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The Toddler Autism Symptom Inventory (TASI): Use in Diagnostic Evaluations of Toddlers

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The Toddler Autism Symptom Inventory (TASI):

Use in Diagnostic Evaluations of Toddlers

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Abstract

Although symptoms of autism are present early in life and early diagnosis can lead to better outcomes, there is a lack of validated parent interviews for children under the age of three. We developed the Toddler Autism Symptom Inventory (TASI), an interview form designed to assess the presence and absence of skills and symptoms in children aged 12-36 months. Reliability of symptoms and diagnosis, and validity of algorithms designed in accordance with Diagnostic and Statistical Manual of Mental Disorders, 5th Edition (DSM-5) and International Classification of Diseases, Tenth Revision (ICD-10) diagnostic criteria were established. Reliability and validity of four algorithms were found to be good (n = 204). A validation sample (n = 91) confirmed these findings, and algorithms showed no reduction in validity in two subsamples of children: those under age 24 months and those with a developmental age below 18 months.

The Toddler Autism Symptom Inventory (TASI):

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Introduction

Autism spectrum disorder (ASD) often emerges early in development; behavioral indications of ASD, including reduced pointing, showing objects to others, looking towards others, and responding to name are often present as early as a child's first birthday (Osterling & Dawson, 1994; Ozonoff et al., 2010). Although predictive validity of specific behaviors is better at 12 months than earlier (Ozonoff et al., 2010; Zwaigenbaum et al., 2005), prospective studies of babies as young as six to seven months with older affected siblings have shown group differences in initiating eye contact (Bhat, Galloway, & Landa, 2010) and fine- and gross-motor skills (Leonard et al., 2014). Young children later diagnosed with ASD show difficulty in disengaging visual attention, reduced eye contact, early passive temperament, reduced expression of positive affect and anticipation during a social interaction, reduced response to name, differences in coordinated hand and eye movements, atypical play behaviors, and repetitive motor movements and motor delays (Jones & Klin, 2013; Leonard et al., 2014; Ozonoff et al., 2008; Paterson et al., 2019; Sacrey et al., 2018; Zwaigenbaum et al., 2005).

In spite of some providers' hesitation about diagnosing ASD in the first two years based on behavioral presentation, diagnoses assigned under the age of two have been shown to be stable and reliable (Chawarska, Klin, Paul, & Volkmar, 2007), even in toddlers who have cognitive, social, and language abilities *under the age equivalent of one year* (Hinnebusch, Miller, & Fein, 2017).

Although ASD symptoms are often present and recognizable early in life, the median age of diagnosis in the United States in 2014 was 52 months (Baio et al., 2018), with later age at

diagnosis especially likely in minority children (Herlihy et al., 2014). Use of developmental screeners such as the Modified Checklist for Autism (M-CHAT R/F; Robins et al., 2014) in young children has been shown to identify children with autism at an earlier age, provided that the child has access to a developmental evaluation that might lead to a diagnosis (Chlebowski, Robins, Barton, & Fein, 2013; Robins et al., 2014; Sánchez-García, Galindo-Villardón, Nieto-Librero, Martín-Rodero, & Robins, 2019). Access to early intervention is typically contingent on early diagnosis, and intervention administered as early as possible leads to better outcomes for children with ASD (Granpeesheh, Dixon, Tarbox, Kaplan, & Wilke, 2009; MacDonald, Parry-Cruwys, Dupere, & Ahearn, 2014; Orinstein et al., 2014; Rogers et al., 2014).

Furthermore, recent evidence suggests that specific brain differences in the first year of life may identify children at particularly high risk for ASD; developmental disorders may be marked by neural markers before behavioral symptoms are apparent (Emerson et al., 2017). Differences in brain growth in ASD over the first two years of life, with small or average head size accelerating in growth to larger head size by the age of one year have been reported for many years (Amaral, Schumann, & Nordahl, 2008; Aylward, Minshew, Field, Sparks, & Singh, 2008; Courchesne, Carper, & Akshoomoff, 2003; Dawson et al., 2007; Dementieva et al., 2005; Lainhart, 2003; Piven, Arndt, Bailey, & Andreasen, 1996). Specific patterns of overgrowth in high-risk infants have been demonstrated to correlate with later social symptom severity (Hazlett et al., 2017). Structural differences are accompanied by functional differences; machine learning applied to functional imaging of infants has demonstrated a high degree of accuracy in predicting later symptom emergence and diagnostic outomes (Bosl, Tager-Flusberg, & Nelson, 2018; Emerson et al., 2017). These and other studies suggest that complex structural and functional

patterns, extractable only with powerful machine learning programs, may be able to identify young children at high risk for ASD in the first year of life.

Emerging neuroimaging and behavioral research suggest that our ability to identify both behaviors and differences in neural functioning indicative of autism early in life is continuously improving. While neuroscience techniques are promising, they have not yet identified and validated clear biomarkers for the disorder (Anderson, 2015), and their application in evaluating all children suspected of having autism might be costly and inefficient. Therefore, the diagnosis of ASD in children continues to rely on behavioral observations and caregiver interview. Interview tools designed for use in developmental evaluations of toddlers will continue to play an important role in the diagnostic process, particularly as more parents and clinicians are cognizant of the early behavioral markers of the disorder.

Diagnostic Interviews for ASD in Toddlers

Parent report of a child's typical daily functioning is an essential component of an evaluation of a young child with autism and is most often acquired through a caregiver interview. During a brief evaluation visit, the child may not demonstrate some behaviors, and the clinician may not be able to observe how frequently certain behaviors are displayed in the child's daily life. Parents of young children are overall very good reporters of their child's abilities (Miller, Perkins, Dai, & Fein, 2017); parent report has been shown to be more predictive of a later ASD diagnosis than clinician observation in children age 12 and 18 months (Sacrey et al., 2018).

While observational and caregiver- or self-report measures are often used in diagnosing autism, a Clinical Best Estimate (CBE) diagnosis is the gold-standard (Chakrabarti & Fombonne, 2005; Charman & Baird, 2002)

An established, widely-used parent interview, the Autism Diagnostic Interview-Revised (ADI-R; Rutter, LeCouteur, & Lord, 2003), is a standardized interview measure used in developmental and diagnostic evaluations when ASD is suspected, and is appropriate for individuals ranging from two years old to adulthood (Rutter, LeCouteur, et al., 2003). However, the ADI-R has been shown to under-diagnose children below 24 months chronological age or 18 months mental age (Lord, Storoschuk, Rutter, & Pickles, 1993), thus missing some children later diagnosed with ASD who may have benefitted from very early intervention.

While toddler-specific scoring algorithms of the ADI-R interview have been developed (Kim & Lord, 2012b), these algorithms use the original ADI-R questions in addition to 32 questions about development, are not specifically designed to query ASD symptoms as they are manifested in toddlers, and are not available widely for clinical use. Separate algorithms have been created for children age 12-20 months or those age 21-48 months who are nonverbal; children with some words age 21-47 months old; and children with phrase speech who are 21-47 months old, with each algorithm being comprised of between 13 and 20 items (Kim & Lord, 2012b). Items assessing behaviors observed currently or ever are both included in the final scoring algorithm. While sensitivity and specificity were high in the original paper (Kim & Lord, 2012b), in other samples sensitivity is lower; 67-70% in children age 21 to 47 months with phrase speech, or 76% in children age 12-20 months and nonverbal children over age 21 months (Kim, Thurm, Shumway, & Lord, 2013). This may be due in part to the low number of very young children without ASD in the sample used to derive algorithms (non-ASD $n = 24$, typically developing $n = 47$; Kim & Lord, 2012). Given that most children have displayed symptoms during the second year of life (Landa & Garrett-Mayer, 2006), and early intervention has been shown to be most effective when children access it as early as possible, the reduced clinical

applicability of the ADI-R in this age range may limit its use in these early diagnostic evaluations.

In addition, administration of the entire ADI-R is lengthy, placing a significant burden on clinicians, parents, and researchers. Publishers of the ADI-R report that this interview takes 90 to 150 minutes (Rutter, LeCouteur, et al., 2003), which is substantial for a single component of a diagnostic and developmental evaluation. Given that waitlists for ASD-related evaluations in some states surpass a year in length, a briefer, more toddler-directed and specific interview focusing on the symptoms most relevant for very young children would aid in shortening evaluation durations and possibly waitlists for evaluations and services, and therefore might allow more children to access timely services early in life. The authors of the ADI-R have recognized the value of a briefer interview, and have recently produced a shorter tool to aid in determining likelihood of ASD in school-age children (Bishop et al., 2017).

While the ADI-R is not the only available semi-structured parent interview for diagnosing ASD, other tools, including the Gilliam Autism Rating Scales (Gilliam, 2014), Social Communication Questionnaire (Rutter, Bailey, & Lord, 2003) and Social Responsiveness Scales (Constantino & Gruber, 2012) are not designed for use in children under age three, four, and four years of age, respectively. To our knowledge, there is no published and validated semi-structured interview specifically designed for parents of toddlers suspected of having an ASD.

Difficulties Associated with Early Diagnosis

Diagnostic criteria for ASD in the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5; American Psychiatric Association, 2013) require that an individual exhibit all three of the social communication symptoms and two of four restricted, repetitive behaviors, interests, or activities (RRB). In addition, symptoms must have been present during early life,

and must confer clinically significant impairment (American Psychiatric Association, 2013). Some studies have indicated that the DSM-5 may under-diagnose ASD in toddlers compared to the DSM-IV-T/R (Barton, Robins, Jashar, Brennan, & Fein, 2013; Christensen et al., 2019; Matson, Kozlowski, Hattier, Horovitz, & Sipes, 2012). For example, a symptom within the social communication domain of the DSM-5 specifies "deficits in developing, maintaining, and understanding relationships" which is difficult to judge in a child age 12 to 36 months. Applying this and other criteria to toddlers requires operationalizing how this might be manifested in this age group.

The International Classification of Diseases, Tenth Revision (ICD-10) Childhood Autism (CA) and Atypical Autism (AA) diagnostic criteria are also commonly used in clinical practice both in the United States and internationally. Though there are slightly different versions of the Childhood Autism diagnostic criteria available for online access; here we used the 1993 published criteria requiring a minimum of six symptoms, including two in the domain of social interaction, one in communication, and one in restricted, repetitive, and stereotyped behaviors. In addition, there must be evidence of early impairment in language, social attachment, or play (World Health Organization, 1993). In order to meet diagnostic criteria for the broader condition Atypical Autism, a child must display abnormalities in social interaction *or* communication *or* RRBs. Similar challenges exist in applying the ICD-10 criteria to toddlers; for example, what level of peer relationships is expected of a child 12-18 months old?

In addition, some research has indicated that very young children with ASD do not always show the well-described higher-order RRBs that are present in older children, such as obsessions with consistency in the environment, or preoccupations with certain objects or activities (Bishop, Richler, & Lord, 2006; Stone et al., 1999; Ventola et al., 2006), although they may show lower-

order RRBs such as repetitive motor movements and sensory abnormalities (Baranek, 1999; Moore & Goodson, 2003; Richler, Bishop, Kleinke, & Lord, 2007). Several groups have suggested that lower thresholds for restricted and repetitive behaviors, particularly for children under age three, may help to identify young children with ASD (Barton et al., 2013; Matson, Hattier, & Williams, 2012).

Differentiating early symptoms of autism from typical development can be challenging. Experiments with young children have revealed well established patterns of emerging social communication and understanding. In autism, deviance from these clear social patterns appears to emerge in the second year of life (Bryson et al., 2007; Zwaigenbaum et al., 2005).

The divergence between typically developing children and those with ASD may be less clear in the area of restricted interests and repetitive behaviors. Very young typically developing children often show repetitive behaviors and play, as well as a preference for routine. Repetitive behaviors are seen in approximately 40% of children under 12 months of age, with strong preferences for routine in children between ages 24 and 35 months of age (Evans et al., 1997). Repetitive motor movements are commonly seen in young children, and are likely associated with motor development (Thelen, 1979), and, in typically developing children, their prevalence decreases as the child ages (Berkson & Tupa, 2000). No differences in the type of repetitive movements that children under three years of age with and without autism engage in have been identified, and while repetitive behaviors are correlated with developmental level, they are also important diagnostically in ASD (Barber, Wetherby, & Chambers, 2012). It appears that the frequency and persistence of RRBs are different in autism compared to typical development.

Thus, an interview tool that clarifies how social communication and repetitive behavior symptoms may be manifested in toddlers with ASD, and how to differentiate these behaviors

from those seen in typically developing toddlers can help improve early diagnostic practices. Focusing the parent interview on *toddler-specific behaviors characteristic of ASD and typical development* may help parents and clinicians identify the skills and symptoms important for diagnosis in children under three years of age. In addition, symptoms of autism that typically do not apply to toddlers were removed, both shortening the interview and avoiding distraction from the most relevant symptoms.

In developing a new interview form, demonstration of both validity and reliability is essential. Validity is the measure's ability to accurately measure the construct of interest; in this case, how well the measure accurately addresses autism symptoms in toddlers. Reliability is the overall consistency of a measure. In the case of a structured interview, inter-rater reliability is the consistency of the use of the measure across interviewers.

Current Study Aims

Given the lack of a succinct and focused toddler-specific diagnostic interview tool with high sensitivity and specificity, we developed the Toddler Autism Symptom Inventory (TASI), a briefer, focused, and easily scorable interview to be used in interviewing parents about a young child's autism symptoms. The TASI is comprised of questions addressing symptoms and behaviors as they are commonly observed in young children with ASD. In addition to the interview form, four scoring algorithms, aligning with DSM-5 and ICD-10 diagnostic criteria, were created. Here we describe the development of this interview and address the following aims:

1. **Assess the inter-rater reliability of the final, shortened TASI interview form** in diagnostic evaluations.

2. **Evaluate the validity of four separate scoring algorithms aligned with DSM-5 and ICD-10 diagnostic criteria when compared with a clinical best estimate diagnosis (CBE) in children aged 12-36 months.** Further, we examine the validity of the TASI in two subsamples: one of children under 24 months chronological age and one with a developmental level below 18 months. Other instruments have been shown to perform more poorly in these very young or developmentally delayed children, and given both the difficulty of assessing children during this dynamic developmental period and the importance of early diagnosis, a close examination of how a diagnostic interview performs in these subsamples is essential for demonstrating utility.

3. **Describe endorsement of behaviors and symptoms in ASD and non-ASD diagnostic groups**, examining which behaviors and symptoms addressed in the TASI interview best discriminate these groups, which are most characteristic of toddlers with ASD, and how frequently symptoms are reported in each group. Symptom endorsement in ASD and non-ASD diagnostic groups will be compared.

Methods

Data reported here were obtained in two stages. First, an interview was administered during developmental evaluations and validity of diagnostic algorithms was calculated from this large sample. These data were then used to develop a briefer, more targeted interview (TASI). Next, the TASI interview was tested and used to calculate inter-rater reliability. The revised TASI interview form is included in the Appendix.

Participants

Children (n =337) between the ages of 12 and 36 months and their caregivers living in Pennsylvania, Georgia, and Connecticut who were a part of the Early Detection of Autism Project (D. Fein, PI; D. Robins, PI) were administered the TASI long form interview during a

developmental evaluation. Children were patients in pediatric practices participating in a study of screening for ASD in early life who were referred for an evaluation after autism-related concerns were raised by their pediatrician or were indicated by a developmental screener. Exclusionary criteria included a previous diagnosis of an ASD and significant sensory or motor impairments that would preclude developmental testing (e.g., blindness, deafness, severe cerebral palsy).

Forty-two interviews (19 children with ASD; mean age 27.25 months, *SD* = 4.14) were excluded for having more than four missing responses. This cutoff of four is arbitrary, and imputation was not employed in order to allow for analyses examining prediction at the individual level. Though some children (*n* = 16) were administered the TASI a second time at a follow-up evaluation approximately two years later, data from the child's first administration only are included here.

Of the 295 children included in this sample, 149 (50%) were White, 69 (23%) were Black or African American, 19 (6%) were Asian, 3 (1%) were American Indian or Alaska Native, 20 (7%) were bi or multiracial, 1 (0.4%) was native Hawaiian or Pacific Islander, 31 (11%) did not report race, and 3 (1%) selected other. 66 (22%) of children were Hispanic or Latino.

Out of the 295 children who were evaluated, 79 (27%) received a diagnosis of DSM-5 ASD, ICD-10 Childhood Autism (CA), or ICD-10 Atypical Autism (AA). The remaining children were diagnosed with language disorders (20%), global delays (21%), other (<1%), or no diagnosis/typical development (TD; 31%).

We divided the sample into two groups based on the time when complete data were acquired. The first sample consists of 204 children and was used to develop and perform initial tests of the algorithms. The second sample, used to validate the algorithms, consists of 91 children. Table 1 reports age, gender, and diagnosis for each sample. ASD groups in the initial

and validation samples were closely matched. The other groups were also well matched on most variables.

Data from children below a chronological age of 24 months (n = 269) and those with a developmental level below 18 months (n = 191) from both the initial and validation samples were compiled to test the algorithm performance on these children for which other interview measures are not appropriate.

Another sample was recruited to evaluate the inter-rater reliability of the final TASI short form. This sample was recruited in Connecticut, Pennsylvania, and California, and is comprised of 38 children (24 male), 74% of whom received a diagnosis of ASD. The relatively higher frequency of ASD in this sample can be attributed to the small sample size. The mean age was 20.10 months (15 – 36 months, SD = 3.18); 21 (55%) were White, 11 (29%) were Black, three (8%) were Asian; two declined to report their race, and one reported "other." Nine (24%) identified as Hispanic.

Thus, analyses are conducted on 5 groups: 1) initial sample, long form interview, 2) validation sample, long form interview, 3) low chronological age sample, long form interview, 4) low mental age sample, long form interview, 5) short form interview.

Measures

Measures used during the developmental and diagnostic evaluation include the Toddler Autism Symptom Inventory (TASI; see Appendix), the Mullen Scales of Early Learning (MSEL), the Autism Diagnostic Observation Schedule – 2 (ADOS-2), as well as demographic and history forms.

The MSEL is an assessment of cognitive abilities designed for use with children age 0-68 months (Mullen, 1995). It assesses skills in the domains of Visual Reception, Fine Motor, Gross

Motor, Receptive Language, and Expressive Language, and provides T-scores for each domain. The MSEL has been shown to have good construct, convergent, and divergent validity in young children with and without ASD (Swineford, Guthrie, & Thurm, 2015).

The ADOS-2 (Lord, Rutter, et al., 2012) is the most widely used observational measure of symptoms of ASD. It is a play-based measure designed to elicit social and communicative behaviors as well as opportunities for children to engage in restricted and repetitive behaviors. The Toddler Module (Lord, Luyster, Gotham, & Guthrie, 2012), designed for use with children age 12 – 30 months, and Module 1, for children over 31 months, were used.

Procedures

Parents of these children completed one or more developmental screeners including the Modified Checklist for Autism in Toddlers – Revised with Follow Up (M-CHAT-R/F; Robins, Fein, Barton, & Green, 2001), First Year Inventory - Lite (FYI-L; Reznick, Baranek, Reavis, Watson, & Crais, 2007), or Infant-Toddler Checklist (ITC; Wetherby, Brosnan-Maddox, Peace, & Newton, 2008) at their child's pediatric well-child check-up. Children were screened at 12, 15, 18, or 24 months, on the schedule their pediatrician was randomly assigned to and those who screened "at risk" on any of these screeners, or whose pediatricians were concerned about possible risk for autism, were invited for a full diagnostic and developmental evaluation at the nearby University clinic or in their pediatrician's office.

Developmental and diagnostic evaluations were conducted by an expert clinician (licensed psychologist or developmental behavioral pediatrician) specialized in ASD and a junior clinician who was a doctoral student in clinical psychology. Legal guardians provided informed consent for themselves and their child to participate. ADOS-2 and MSEL scores in the initial and validation samples are reported in Table 1. Evaluations lasted on average three to four hours. The

study was approved by the Institutional Review Boards at Drexel School of Medicine, the UC Davis MIND Institute, University of Connecticut, and Georgia State University.

Final diagnosis was a clinical best estimate by the senior clinician, based on information gathered from the ADOS-2, TASI, MSEL, information about the child's history and current behaviors, and behavioral observations. Clinical best estimate has been determined to be the gold standard in diagnosing ASD (Klin, Lang, Cicchetti, & Volkmar, 2000; Ventola et al., 2006). Because we intended to evaluate algorithms aligned with DSM-5 and ICD-10 criteria, a diagnosis within each diagnostic system was assigned. Thus, some children were diagnosed with Childhood Autism (CA) or Atypical Autism (AA) in the ICD system and ASD as per DSM-5. Others only received an AA diagnosis, because the ASD criteria are more stringent than AA criteria. At the end of the evaluation, children who met criteria were given a diagnosis, their developmental status described, and verbal recommendations given to parents; a full written report followed.

TASI Interview Form Development

The original interviews from which data was used to generate algorithms and design the new TASI form were a compilation of behaviors and symptoms that numerous researchers and clinicians identified as being useful in their clinical practices. Data from the initial, long-form TASI interviews with children's parents were collected and compiled into a database. Responses were categorized into dichotomous categories indicating symptom presence or absence. Each existing TASI question was evaluated for its fit within the DSM-5 and ICD-10 diagnostic criteria. All questions that did not align directly with the diagnostic criteria were removed. In addition, clinicians reported that some questions were often misunderstood by parents (e.g., Does

your child use this language flexibly, using many different word combinations as appropriate to the situation?). These ambiguous items were also removed from the final version of the TASI.

Assigning each TASI question to a single symptom within each set of diagnostic criteria was a challenge, as we have previously found with other measures (Barton et al., 2013). Although our team came to agreement on which symptom each item best aligned with, other practitioners may interpret some items on the TASI as being attributed to other symptoms, especially in the domain of social communication.

The TASI is comprised of thirty-seven interview questions, and a simplified table for eliciting sensory symptoms (see Appendix). This table includes 29 examples of sensory symptoms often observed in toddlers with ASD and categorizes them into sensory-seeking, hyper-sensitivity, and hypo-sensitivity behaviors. The number of questions aligned with each symptom, and the number required to classify the symptom as present are presented in Table 2.

TASI Algorithm Development

The streamlined TASI interview form and scoring algorithm document can be found in its entirety in the Appendix. In this study, data from the initial sample (n = 204) were analyzed and algorithms to establish cut-offs for DSM-5 and ICD-10 diagnoses were created. Four independent algorithms were created: one for DSM-5 criteria, one for relaxed DSM-5 criteria as proposed by Barton et al. (2013), one for ICD-10 Childhood Autism, and one for ICD-10 Atypical Autism. Algorithms are included in the scoring document in the Appendix. Rather than calculating a total score, as some diagnostic tools do, scores are calculated for each symptom and a series of cutoffs for all symptoms were used to evaluate whether a child met diagnostic criteria on the TASI or not.

Algorithm cutoffs were first determined using Receiver Operating Characteristic (ROC) curves, as is standard in the field (Kim & Lord, 2012b). Subsequently, the percent of children in autism and non-autism diagnostic groups who endorsed each symptom was evaluated, and minor changes to algorithm cutoffs (e.g., requiring one more endorsed behavior) were implemented in order to achieve high symptom endorsement in the autism group and low endorsement in the non-autism groups. Algorithm cutoffs for the TASI are described in Table 2.

Reliability and Validity

Data from the original long-form TASI were compiled to calculate sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). After the algorithms had demonstrated adequate validity in the initial sample (n = 204), these algorithms were tested on the cross-validation sample (n = 91).

Inter-rater reliability was established by having a second clinician review tapes of the TASI administration and independently record caregiver responses and score the TASI for 38 administrations of the revised TASI interview. Percent agreement and intraclass correlation coefficients (ICCs) were calculated to demonstrate agreement of symptom-level and diagnosis-level algorithm output.

Other interviews used for the assessment of ASD in young children have demonstrated reduced sensitivity in children under age 24 months chronological or 18 months developmental age (Lord et al., 1993), highlighting an important need for an appropriate measure for this population. Therefore, we also combined the initial and validation samples and stratified on age and cognitive level to determine the validity of this measure in samples of very young children and in those with lower cognitive abilities.

Item- and Symptom- Level Analysis

Fishers exact tests were used to identify significant differences in the percent endorsement of each TASI question between diagnostic groups. Behaviors most frequently endorsed for autism, behaviors endorsed frequently for both autism and non-autism developmental delay groups, and behaviors endorsed infrequently by the autism group were also examined for content.

At the symptom-level, the frequency of endorsement of each symptom across diagnostic groups was examined to determine which symptoms are most frequently observed in toddlers with ASD and other developmental delays.

Results

TASI Algorithm Development

The TASI is comprised of 37 questions, as well as a sensory table with three components. These are combined into symptoms based on the DSM-5 and ICD-10 criteria. The number of TASI questions that address each symptom, as well as the number of TASI questions that must be endorsed to consider the symptom present are listed in Table 2. After determining if each symptom is present based on responses to TASI questions, whether the child meets DSM-5 or ICD-10 criteria is determined based on how many symptoms are endorsed.

Using the initial sample, Receiver Operating Characteristic (ROC) curves were calculated for each DSM-5 and ICD-10 symptom and Area Under the Curve (AUC) results are reported in Table 3. ROC curve analyses indicated the optimal threshold for every symptom was found to be 1. This mirrors other work requiring only a single affirmative response to indicate symptom presence (Huerta, Bishop, Duncan, Hus, & Lord, 2012). Several symptoms showed an AUC between 0.8 and 0.9 (DSM-5 social-emotional reciprocity, relationships, and stereotyped movements or vocalizations). Some items were lower (AUC = 0.7-0.8), including DSM-5

nonverbal communication and restricted interests, and ICD-10 reciprocal social interaction symptoms, restricted, repetitive behavior/interest symptoms, and the conversational exchange communication symptom. Other items were close to chance ($AUC < 0.69$) (DSM-5 insistence on sameness and sensory differences, as well as the ICD-10 symptoms within the communication domain: Delay/lack of spoken language; repetitive language use; pretend/imitative play). Given that our algorithms required a combination of these symptoms in order to suggest that ASD is likely, the accuracy of each symptom alone in predicting ASD is not expected to be high.

Though ROC curves indicated that optimal cutoffs for all items were 1, we used clinical judgment to adjust the number of required symptoms for the DSM-5 social-emotional reciprocity symptom from one to two, because the behaviors addressed in this section were absent in many children referred for an evaluation. While 99% of children diagnosed with autism endorsed at least one of these behaviors, 72% of children identified to be typically developing did as well. When two behaviors were required, 94% of children with autism and 18% of typically developing children met the cutoff; this effective discrimination led us to adopt that cutoff. For all ICD-10 symptoms, only a single endorsed item was necessary to indicate symptom presence.

Final algorithm cutoffs specifying which and how many symptoms were necessary were derived directly from the DSM-5 and ICD-10 diagnostic criteria. To meet the TASI DSM-5 ASD algorithm, all three social communication symptoms as well as two of the four restricted repetitive behaviors or interests were required. The TASI relaxed DSM-5 algorithm required two of three social communication symptoms in addition to at least one RRB, the optimal modification for toddlers described by Barton et al. (2013).

For the TASI ICD-10 Childhood Autism algorithm, two of four social symptoms, as well as one of four communication and RRB symptoms each are required. The TASI Atypical Autism algorithm requires at least one symptom in each domain.

Symptom-level and diagnosis-level algorithm cutoffs are clearly indicated on the TASI scoring sheet included in the Appendix.

Reliability

Percent agreement was calculated between two independent evaluators for each question on the TASI. These values are reported in Table 4. The mean percent agreement was found to be 87.68% (76.32% – 100%), indicating that independent raters showed good agreement.

At the level of symptom and diagnosis, the intraclass correlation coefficient (ICC; SPSS One-Way Random Effects Model) was calculated. These values are presented in Table 5. For the DSM-5 and relaxed DSM-5 diagnoses, ICCs were 0.849 and 0.865, both showing good reliability (Koo & Li, 2016). Of the seven symptoms in the DSM-5, two (A1: social-emotional reciprocity and A3: relationships) were found to have poor reliability, while the others demonstrated good or excellent reliability (Koo & Li, 2016). Poor agreement in the domain of social-emotional reciprocity may be due to certain interviewers requiring that behaviors be more frequent in order to indicate asymptomatic, while poor agreement in relationships is likely due to difficulty of assessing relationship abilities in young children. For the ICD-10 Childhood Autism and Atypical Autism diagnoses, ICC's were 0.911 (excellent) and 0.847 (good). All symptoms within the ICD-10 diagnosis were found to have at least moderate reliability, with two items showing excellent reliability. Overall, reliability across raters was determined to be acceptable.

Validity

Sensitivity, specificity, PPV, and NPV for our initial sample and validation sample were calculated for each diagnostic algorithm. Children were assigned a CBE diagnosis in both DSM-5 and ICD-10 diagnostic systems, and each algorithm output was compared to the appropriate CBE diagnosis. For example, the ASD TASI algorithm was compared to the DSM-5 CBE diagnosis, while the AA and CA TASI algorithms were compared to the ICD-10 CBE diagnosis. To evaluate the DSM-5 relaxed algorithm, algorithm output was compared to an Atypical Autism diagnosis, since this is the least restrictive. Because DSM-5 criteria are more stringent, some children met Atypical Autism criteria under ICD-10 but did not meet DSM-5 ASD criteria. Of the 79 children diagnosed with *any autism condition by clinical best estimate*, 79 met AA criteria, 72 met ASD criteria, and 60 met CA criteria.

Sensitivity was defined as the percent of children with a CBE diagnosis of autism who met the TASI algorithm criteria. Specificity was defined as the percent of children diagnosed as having a non-ASD disorder or being typically developing who did not meet TASI algorithm criteria. PPV was defined as the percent of children who met TASI criteria for a diagnosis who were judged to have a CBE diagnosis of autism. NPV was defined as likelihood of not having autism in children who did not meet TASI algorithm criteria. Results are summarized in Tables 6 (initial sample) and 7 (validation sample). In the initial sample, for the DSM-5 ASD diagnostic algorithm, a sensitivity of 52.83 and specificity of 92.72 suggest that while this algorithm failed to appropriately capture nearly half of children with a clinical best estimate diagnosis of ASD, only 8% were false positives. The DSM-5 relaxed algorithm yielded a sensitivity of 82.76 and specificity of 77.40. While this algorithm "captured" more children with a clinical best estimate diagnosis, 23% of non-autistic children were identified as false positives using this algorithm. The ICD-10 Childhood Autism algorithm successfully identified 69% of children with a CBE

diagnosis, while maintaining a high specificity; only 11% were false positives. The ICD-10 AA algorithm demonstrated the highest sensitivity at 84.48 with a specificity of 71.23, identifying nearly 30% of children without autism as false positives.

In the validation sample (Table 7), similar patterns were observed, with some slight differences that may be in part due to the smaller sample size. Again, the DSM-5 relaxed algorithm yielded better sensitivity and poorer specificity when compared with the DSM-5 ASD criteria. The DSM-5 criteria had high specificity (90.28) but low sensitivity (57.89), again failing to identify nearly half of children with a CBE ASD diagnosis. Of children with an ICD-10 CA diagnosis, this algorithm correctly identified 93%, which is significantly higher than in the initial sample. The specificity of the CA algorithm was 80.26, indicating that 80% were true positives. The ICD-10 AA algorithm accurately captured 100% of children with a CBE of AA yet also identified 41% of the non-autism group as false positives.

We also examined sensitivity, specificity, PPV, and NPV in children with a low chronological (below 24 months) and low mental age (below 18 months, as quantified by the Visual Reception scale of the MSEL). These values are reported in Table 8. Sensitivity, specificity, PPV, and NPV were largely similar to those calculated in the initial sample, providing support for the use of the TASI in these very young or very delayed children.

It is also important that such an interview tool not result in a high number of false-positives, incorrectly identifying children who do not meet diagnostic criteria. Positive predictive values indicate the likelihood of having a best-estimate clinical diagnosis if the algorithm cutoffs were met. In the initial sample, PPV values range from 53.85 to 71.79, suggesting that 47% to 29% of children not diagnosed with ASD do in fact meet algorithm criteria. However, many false positives were of children determined to have *other* developmental disorders. 82% of false

positives on the Childhood Autism algorithm cutoffs (52% being children diagnosed with AA), 57% of false positives on the Atypical Autism algorithm cutoffs, 90% of false positives on the ASD DSM-5 algorithm cutoffs (with 30% being diagnosed with AA), and 73% of false positives on the DSM-5 relaxed ASD algorithm cutoffs had another developmental disorder.

Item- and Symptom-Level Analysis

Item-level. Fisher's exact tests were used to compare item responses in the ASD group to those with another diagnosis and those with typical development. All TASI questions were endorsed more frequently in the ASD group compared to other groups; percent endorsement of each item is presented in Table 10. 65% of TASI questions significantly discriminated between ASD and both non-autism groups. Of the 40 items (37 items, plus 3 sensory domains) within the TASI, 12 were found to be *present in at least 50% of children diagnosed with any autism condition by clinical best-estimate and to significantly discriminate autism from the other groups*. Within the social domain, these items included: approaching others to play or interact, showing things the child has done, looking to see if a parent is looking at the same thing, responding to an approaching child, spontaneous imitation, and engaging in pretend play with others. In the RRB domain, engaging in specific repetitive play; engaging in unusual body movements; having an intense interest in a particular activity or toy; carrying or playing with an atypical, non-toy object; and engaging in sensory seeking behaviors or those suggesting hyper-sensitivity to sensory stimuli were reported at high rates by the ASD group. Importantly, no behaviors addressing the Insistence on Sameness (B2) symptom of the DSM-5 were endorsed by more than 20% of children with autism.

Symptom-level. Percent endorsement of each symptom by group is presented in Table 10. An examination of the frequency of symptom endorsement revealed different patterns of symptom endorsement across groups, with the ASD group showing the highest rates of endorsement of all symptoms. Some symptoms, including social-emotional reciprocity, nonverbal communication, and relationships showed stepwise differences, with the ASD group showing most frequent endorsement, followed by the other developmental disorders group, and finally the typically developing group. Other symptoms, including insistence on sameness, restricted interests, and sensory differences showed much higher rates of endorsement in the ASD group and equal rates of endorsement between the other diagnosis and typically developing groups.

Discussion

Here we present the TASI, a structured interview for use in diagnostic evaluations of children age 12 to 36 months suspected of having an autism spectrum disorder. Currently, there are few evidence-based interviews designed for use with parents of children under three years of age with suspected developmental delays or differences. The TASI was designed to assist in diagnosis using the DSM-5 and ICD-10 criteria.

The TASI was designed using a long-form interview which was shortened to create a more practical measure directly aligned with the DSM-5 and ICD-10 diagnostic criteria. The interview uses language designed to be brief and comprehensible to parents. ROC curve analyses combined with clinical judgement and consideration of percent endorsement across diagnostic groups were used to develop algorithm cutoffs for each symptom.

Algorithms for ICD-10 Childhood Autism (CA) and Atyipcal Autism (AA), as well as DSM-5 ASD and a relaxed DSM-5 diagnosis were created based upon the diagnostic criteria and

prior work suggesting ideal cutoffs for applying the DSM-5 to toddlers (Barton et al., 2013). ICD-10 CA and DSM-5 ASD algorithms were more stringent, requiring more symptoms to meet threshold, and thus had higher specificity and lower sensitivity compared to ICD-10 AA or DSM-5 relaxed ASD criteria. The relaxed DSM-5 ASD algorithm favors high sensitivity over specificity, while the ICD-10 AA algorithm offers a more equal balance of sensitivity and specificity. The flexibility afforded by the TASI enables its use across contexts, including genetic studies which may favor specificity, and intervention studies that may favor sensitivity, and is similar to ranges of concern used by other measures (Kim & Lord, 2012b).

Work examining the ADI-R toddler algorithm has previously determined sensitivity to range from 67 to 100 and specificity to range between 64 and 94 (Kim et al., 2013). The TASI's ICD-10 AA and CA, and the DSM-5 relaxed algorithms all perform similarly to the ADI-R in this young sample, offering comparable utility with a smaller investment of time. Our DSM-5 ASD algorithm yields higher specificity at the cost of lower sensitivity. Importantly, the analyses in Kim et al (2013) include children up to 47 months of age, significantly older than those included here, which may have improved the psychometrics of the ADI-R. In addition, sensitivity is lowered by the identification of children with non-autism developmental delays. The TASI is based exclusively on parent report and, like all other interview measures (Kim & Lord, 2012a), should always be used in conjunction with other observational measures (e.g., ADOS-2), which confer more information about a child's presentation and reduces the risk of misdiagnosis.

Although other interview tools have shown reduced sensitivity in children under age 24 months chronological age or 18 months developmental age (Lord et al., 1993), the sensitivity and specificity of the TASI for both of these groups are remarkably similar to that of the Initial

Sample, which included children age 12 – 36 months of age. We saw no decrease in validity for this age and developmental group.

Negative predictive value, or the probability that a child who is scored as *not* having ASD on the TASI will not have autism, is important when considering access to early intervention. Failing to identify a child with ASD and thus disqualifying that child from accessing early intensive services is a key concern when evaluating an interview designed for use with very young children. The TASI was found to have high negative predictive values, such that only approximately 8% of children who score as non-ASD on the ICD-10 CA, AA, and DSM-5 relaxed algorithms will in fact receive an ASD clinical best-estimate diagnosis.

Item- and Symptom-Level Analysis

Item-level. While every item on the TASI was more frequently endorsed in the ASD group, all symptoms were endorsed by a small number of parents of children in the typical-development or other-disorder groups. The TASI is designed to pick up on subtle developmental differences, and many of the behaviors of interest are present to some degree in typical development and in neurodevelopmental delays in general. Therefore, the presence of a small number of the behaviors addressed on the TASI is not necessarily indicative of autism.

The most frequently absent or reduced social-communicative behaviors in the ASD group included: approaching others to play or interact, showing things the child has done, looking to see if a parent is looking at the same thing, responding to an approaching child, spontaneous imitation, and engaging in pretend play with others. All of these items were endorsed by at least 50% of the parents of children with ASD, and they differentiated the ASD group from the other-diagnosis and typical development groups. The Restricted Repetitive Behavior items endorsed by at least 50% parents of children diagnosed with ASD include: engaging in specific repetitive

play, engaging in unusual body movements, having an intense interest in a particular activity or toy, carrying or playing with an atypical, non-toy object, and engaging in sensory seeking behaviors or those suggesting hyper-sensitivity to sensory stimuli. These behaviors are frequently displayed in children receiving a clinical best-estimate diagnosis of autism, and differentiate children with autism from those with other disorders; their inclusion in a parent interview is essential.

Certain items were found not to differentiate between children diagnosed with ASD and other developmental delays. These include items about whether a child smiles in response to the primary caregiver's smile, how the child responds to an adult who is hurt or sad, whether the child engages in hand or finger flapping or rocking, engaging in back-and-forth conversations (using either words or babbling), and engaging in social games like peek-a-boo. Some of these behaviors may be characteristic of delayed development in general (e.g, hand flapping, not noticing the internal states of others), while others are present, at least to some degree, in all children, including those with ASD at certain developmental stages (e.g., smiling in response to the primary caregiver's smile) (Bryson et al., 2007). It is possible that these behaviors may be more discriminative earlier or later in development (Zwaigenbaum et al., 2005), and addressing them in a parent interview may garner useful information, but further work should explore their developmental trajectory.

Symptom-level. The frequency of endorsement of each symptom is presented in Table 10. Those receiving a DSM-5 ASD, ICD-10 CA, or AA diagnosis are included in the ASD group. In the social communication domain of the DSM-5, the symptom least frequently identified by caregivers of children with autism (62.07%) is nonverbal communication. The questions addressing social communication on the TASI assess how a child engages in nonverbal

communication with the primary caregiver. Anecdotally, many children with autism have stronger connections to their primary caregiver that are difficult to generalize to others. Primary caregivers are usually the persons being interviewed for the TASI, and it may be challenging for parents to state whether certain behaviors (e.g., looking while making a request) are present at a developmentally appropriate level. The presence of these behaviors may simply be better captured using observational measures like the ADOS-2. An additional, exploratory, item has been included in the TASI interview form here addressing how frequently the child looks towards a stranger or less-familiar adult. This item was not included in the interview administered in this project and therefore has not yet been empirically validated. For this reason it is not included in the scoring algorithm but its utility will be evaluated in the future.

Relationship and stereotyped movement symptoms are endorsed at high levels in both the other diagnosis group and the typically developing group, suggesting that there are broad ranges of appropriate behavior within this developing population. Failure to engage in pretend play with others is the most frequently endorsed relationship symptom in the typically developing group, which is a skill we know to be emerging in the 12-36 month age range (Fein, 1981). Similarly, stereotyped movements are common in particular developmental phases associated with motor development in typically developing young children (Thelen, 1979).

In the RRB domain, insistence on sameness is identified in the ASD group only 34.48% of the time. The mean age of the 20 toddlers with ASD demonstrating this symptom was 23.2 months, compared to a mean age of 19.6 months in children with ASD not demonstrating the symptom. It is likely that insistence on sameness is a behavior that emerges later in development (Bishop et al., 2006), perhaps after 20 months of age. It is possible that some children between the ages of 12 and 36 months may not yet have the cognitive capacities to insist on sameness or

even to detect subtle changes in routines or environment. Alternatively, it is possible that manifestations of insistence on sameness in this developmental group may be expressed as repetitive play or other behaviors that are better captured in this very young age group under other symptoms (e.g., repetitive movements or use of objects). DSM-5 diagnostic criteria require that two out of four symptoms be met in the RRB domain; if very-young children do not demonstrate behaviors characteristic of insistence on sameness, this threshold may be inappropriately demanding and delay diagnoses in some children. While the DSM-5 ASD criteria aimed for more strictly defined ASD, thereby increasing specificity (McPartland, Reichow, & Volkmar, 2012), such restrictive symptom criteria may unnecessarily limit which young children can gain access to essential early intervention services.

The TASI and Diagnostic Criteria

Four independent algorithms used to score the TASI have been evaluated here. The TASI interview permits all four algorithms to be scored and provides an indication of whether each symptom is present or absent. This may help clinicians best integrate information acquired from this parent interview with direct-observation obtained through other measures (e.g., ADOS-2).

The DSM-5 algorithm, which directly aligns with the DSM-5 diagnostic criteria, consistently shows high specificity but sensitivity near 50%, thus missing nearly half of children with a CBE diagnosis. Many concerns about the applicability of the DSM-5 diagnostic criteria have been expressed (Barton et al., 2013; Matson, Kozlowski, et al., 2012), and here we demonstrate that even with a clear operationalization of the DSM-5 symptoms, many children with a CBE diagnosis are not identified. Past work has also demonstrated high specificity and low sensitivity of the DSM-5 using parent-reported information (Huerta et al., 2012).

The relaxed DSM-5 algorithm provides some improved sensitivity with lower specificity, thus better capturing children missed by stringent DSM-5 criteria. The ICD-10 CA and AA algorithms, however, better balance sensitivity and specificity.

Each algorithm's psychometrics are distinct and allow for a research or clinical team to prioritize sensitivity or specificity based on their own needs. A genetic study, for example, may prioritize specificity while a treatment study may prioritize sensitivity.

TASI Use in Developmental Evaluations

The TASI has been shown to perform well in children age 12 to 36 months referred for developmental evaluations, including those under 24 months chronological age and children under 18 months mental age. Other existing interviews have been shown to perform more poorly in these very young children and those with developmental delays (Lord et al., 1993), yet the TASI shows no reduction in validity in this population compared to our larger sample.

The TASI is also a more efficient tool than other ASD interview forms which can be lengthy to administer. On average, the TASI interview as part of a clinical evaluation takes 40 minutes, and is used in conjunction with standardized measures (e.g., the ADOS-2), behavioral observations, a brief history interview, and cognitive testing. The TASI is easy to administer and score immediately, making it an appropriate addition to testing both in clinics and in research contexts. The interview form, scoring manual, and scoring document are included in the Appendix.

In addition, the TASI is directly aligned with DSM-5 and ICD-10 diagnostic criteria, in contrast to the ADI-R, which was originally created for DSM-IV ASD diagnoses. In addition, cutoffs are specified for each symptom, rather than a cutoff for a total score. The toddler ADI-R

algorithms can in fact return an ASD-likely result even when no RRB symptoms are reported, if scores on social and communication domains are high enough to exceed the cutoff (Kim & Lord, 2012b). While the authors have described this as a useful approach, our results, which indicate that while requiring two of four RRB symptoms, as the strict DSM-5 criteria do, results in lowered sensitivity, requiring at a minimum one (as the relaxed DSM-5 criteria does) is appropriate and does not result in many young children failing to meet these criteria.

The TASI is comprised of a single interview form with four scoring algorithms. The accompanying scoring tool can enable a provider or research team to better understand which symptoms are present and which are not currently evident. There is great variation in terms of the behaviors and skills that are present in typically- and atypically-developing children at this developmental stage. Therefore, it is essential to have a tool that allows for the gathering and integration of information to allow a clinician to evaluate the child's overall presentation, including their strengths and weaknesses.

The TASI should always be used in conjunction with other diagnostic tools, including a complete history, behavioral observations, and structured observational tools. Combining parent-report instruments and direct-observation improves sensitivity of these tests to identify those with a clinical best-estimate diagnosis of ASD (Risi et al., 2006).

Limitations and Future Directions

Several limitations should be noted. First, it is likely that others may assign certain TASI questions to different symptoms within each diagnostic criteria than our team did. Part of this issue is due to the difficulty of applying diagnostic criteria for very young children and the lack of agreement in the field. While our group reached consensus, it is possible that others may interpret the diagnostic criteria differently in toddlers.

In addition, the validity data analyzed in this study came from a long-form administration of the TASI, which is longer than the version included here. It is possible that when administered as the shorter version, differences may arise, given that parents are presented with a reduced number of overall questions. Good reliability was demonstrated using 38 TASI interviews, which is clearly insufficient for reporting validity data. Future work will examine the psychometrics of the shortened form administered as published here.

Conclusions

The Toddler Autism Symptom Inventory (TASI) is a parent interview tool developed to be used in developmental evaluations of toddlers suspected of having an autism spectrum disorder. The TASI is designed to address symptoms of autism spectrum disorders as they are displayed in very young children, and aids in differentiating behaviors characteristic of autism, other developmental disorders, and typical development. We have demonstrated here that the TASI shows good reliability and validity and is an improvement over existing measures. Furthermore, we have explored the endorsement of behaviors and symptoms to better understand the early presentations of autism and other developmental delays in early childhood. In early childhood, parent-reported social behaviors are significantly different in children diagnosed with autism compared to other children, and these social behavioral deficits span all DSM-5 social communicative domains. There are also some restricted or repetitive behaviors that are more apparent in autism compared to non-autism, particularly those involving repetitive play and movements, as well as sensory interests, however, insistence on sameness behaviors are not widely reported. Symptoms of autism emerge early, and span both social and RRB behaviors, even in toddlerhood.

Table 1. Demographics and Descriptive Statistics for autism, other daignosis, or no diagnosis groups in initial and validation samples.

	Autism[a]			Other Diagnosis			Typical Development/No Diagnosis		
	Initial (n=58)	**Validation (n=21)**	**X^2**	**Initial (n=76)**	**Validation (n=48)**	**X^2**	**Initial (n=70)**	**Validation (n=22)**	**X^2**
# male (%)	44 (76%)	16 (76%)	.001	52 (68%)	33 (69%)	.001	37 (53%)	12 (54%)	.019
Mean (SD)			**t**			**t**			**t**
Age in months (SD)	20.9 (4.45)	22.66 (5.40)	-1.50	18.32 (2.99)	19.08 (3.52)	-1.30	18.37 (3.26)	18.18 (5.75)	0.15
MSEL ELC Standard Score [b]	64.21 (15.65)	65.14 (15.97)	-.225	71.76 (11.55)	69.13 (11.25)	1.284	93.84 (13.16)	96.41 (12.60)	-.630
MSEL VR T-score [c]	32.5 (12.17)	33.67 (11.85)	-.379	39.20 (11.93)	37.54 (9.77)	.806	48.76 (9.51)	48.72 (11.52)	.012
ADOS-2 total score	19.43 (5.04)	18.38 (3.61)	.876	6.25 (3.79)	6.27 (3.98)	-.024	3.44 (2.65)	5 (3.18)	*-2.289**
ADOS-2 SA	15.25 (4.72)	14.67 (2.94)	.537	5.96 (3.66)	5.69 (3.39)	.415	3.17 (2.52)	4 (2.35)	-1.366
ADOS-2 RRB	3.90 (1.93)	3.71 (1.87)	.373	0.29 (0.67)	0.92 (1.30)	*-3.065**	0.27 (0.54)	1 (1.45)	*-2.312**

MSEL: Mullen Scales of Early Learning; ELC: Early Learning Composite; VR: Visual Reception; ADOS-2: Autism Diagnostic Observation Scale, Second Edition; SA: Social Affect; RRB: Restricted Repetitive Behavior

[a] Autism Spectrum Disorder, Childhood Autism, or Atypical Autism diagnosis

[b] MSEL ELC standard score (mean = 100, SD = 15)

[c] MSEL VR t-score (mean = 50, SD = 10)

* $p < 0.05$; ** $p < 0.01$

Table 2: TASI items and cutoffs for DSM-5 and ICD-10 symptoms

DSM-5	# relevant items on TASI	# items required
A1: Social-emotional reciprocity	9	2
A2: Nonverbal communication	6	1
A3: Relationships	5	1
B1: Repetitive movements, object use, speech	8	1
B2: Insistence on sameness	4	1
B3: Restricted or fixated interests	2	1
B4: Sensory symptoms	Sensory Table*	1
ICD-10	# relevant items on TASI	# items required
1a: Integrated nonverbal communication	5	1
1b: Peer relationships	3	1
1c: Social-emotional reciprocity	5	1
1d: Spontaneous engagement-seeking	4	1
2a: Delay/lack of spoken language	1	1
2b: Conversational exchange	1	1
2c: Repetitive use of language	3	1
2d: Pretend/imitative play	2	1
3a: Encompassing preoccupation	1	1
3b: Adherence to routines or rituals	5	1
3c: Motor mannerisms	4	1
3d: Sensory/non-functional interests	1 + Sensory Table*	1

* See Sensory Table, Appendix

Table 3. Area under the Curve values for each symptom in DSM-5 and ICD-10.

DSM-5	ROC Area Under the Curve
A1: Social-emotional reciprocity	.825
A2: Nonverbal communication	.734
A3: Relationships	.844
B1: Repetitive movements, object use, speech	.857
B2: Insistence on sameness	.640
B3: Restricted or fixated interests	.787
B4: Sensory symptoms	.691
ICD-10	
1a: Integrated nonverbal communication	.716
1b: Peer relationships	.752
1c: Social-emotional reciprocity	.734
1d: Spontaneous engagement-seeking	.790
2a: Delay/lack of spoken language	.623
2b: Conversational exchange	.605
2c: Repetitive use of language	.614
2d: Pretend/imitative play	.738
3a: Encompassing preoccupation	.731
3b: Adherence to routines or rituals	.758
3c: Motor mannerisms	.788
3d: Sensory/non-functional interests	.759

Table 4. Percent agreement of independent raters of each TASI item

TASI item	Percent Agreement
Language Delay	81.58
1 Smile back to caregiver	94.74
2 Smile back to other	100
3 Response to happy	86.84
4* Response to hurt adult	94.74
5 Response to name	94.74
6 Approach to play	89.47
7 Show done/doing	76.32
8 Show interest	84.21
9 Back-and-forth talking/babbling	81.58
10 Social games	86.84
11 Look when requesting	86.84
12 Look back when showing	92.11
13 Look during physical play	94.74
14 Look during social play	94.74
15* Gestures	92.11
16 Gesture frequency	84.21
17 Follow point	92.11
18 Interest in children	94.75
19 Usual play	86.84
20 Approaching child	86.84
21 Spontaneous imitation	84.21
22 Pretend play	81.58
23 Pretend play with others	81.58
24 Inflexible play	86.84
25 Flapping	81.58
26 Repetitive hand movements	76.32
27 Rocking	94.74
28 Unusual body movements	76.32
29 Repeat vocalizations	78.95
30 Immediate echolalia	89.47
31 Delayed echolalia	92.11
32 Routine change	89.47
33 Minor changes	92.11
34 Minor, indirect changes	94.74
35 Impose routines	92.11
36 Strong interest	86.84
37 Atypical object	81.58
Sensory Seeking	86.84

Hyper-sensitivity	81.58
Hypo-sensitivity	89.47

Table 5. Intraclass Correlation Coefficient (ICC) by diagnosis and symptom.

Diagnosis	Intraclass Correlation Coefficient
DSM-5 ASD	0.849**
DSM-5 relaxed	0.865**
ICD-10 CA	0.847**
ICD-10 AA	0.911***
DSM-5 symptoms	Intraclass Correlation Coefficient
A1	0.423
A2	0.908**
A3	0.231
B1	0.728*
B2	0.769**
B3	0.846**
B4	0.907***
ICD-10 symptoms	
1a	0.834**
1b	0.900***
1c	0.924***
1d	0.782**
2a	0.709**
2b	0.771**
2c	0.569*
2d	0.728*
3a	0.849**
3b	0.780**
3c	0.715*
3d	0.728*

*: moderate reliability; **: good reliability, ***: excellent reliability

Table 6. Sensitivity and specificity values for initial sample used to develop the algorithms.

Initial Sample		**ICD-10 CA (95% CI)**	**ICD-10 AA (95% CI)**	**DSM-5 ASD (95% CI)**	**DSM-5 relaxed ASD (95% CI)**
all children (n=204; 59 (29%) clinical diagnosis of ASD)	sensitivity	68.89 (53.35 – 81.83)	84.48 (72.58 – 92.65)	49.06 (35.06 – 63.16)	82.76 (70.57 – 91.41)
	specificity	89.31 (83.43 – 93.65)	71.23 (63.17 – 78.42)	93.38 (88.16 – 96.78)	77.40 (69.75 – 83.90)
	PPV	64.58 (52.76 – 74.86)	53.85 (46.91 – 60.64)	72.22 (57.36 – 83.40)	59.26 (51.31 – 66.75)
	NPV	91.03 (86.75 – 94.02)	92.04 (86.27 – 95.51)	83.93 (79.98 – 87.22)	91.87 (86.46 – 95.24)

CA, Childhood Autism; AA, Atypical Autism; ASD, Autism Spectrum Disorder; PPV, positive predictive value; NPV, negative predictive value

Table 7. Sensitivity and specificity values for cross-validation sample used to test algorithms.

Validation Sample		**ICD-10 CA (95% CI)**	**ICD-10 AA (95% CI)**	**DSM-5 ASD (95% CI)**	**DSM-5 relaxed ASD**
all children (n=91; 20 (22%) clinical diagnosis of ASD)	sensitivity	93.33 (68.05 – 99.83)	100 (83.16-100)	57.89 (33.50 – 79.75)	90.48 (69.62 - 98.83)
	specificity	80.26 (69.54 – 88.51)	59.15 (46.84 – 70.68)	90.28 (80.99 – 96.00)	65.71 (53.40 - 76.65)
	PPV	48.28 (36.77 – 59.97)	40.82 (34.27 – 47.71)	61.11 (41.35 – 77.79)	44.19 (35.75 - 52.98)
	NPV	98.39 (90.15 – 99.75)	100	89.04 (82.67 – 93.26)	95.83 (85.89 - 98.86)

CA, Childhood Autism; AA, Atypical Autism; ASD, Autism Spectrum Disorder; PPV, positive predictive value; NPV, negative predictive value

Table 8. Sensitivity and specificity values for all children under chronological age of 24 months or developmental age of 18 months. Mental age = VR MSEL

		ICD-10 CA (95% CI)	**ICD-10 AA (95% CI)**	**DSM-5 ASD (95% CI)**	**DSM-5 relaxed ASD (95% CI)**
Developmental age (VR MSEL) 18 mo and under (n=191; 55 (29%) CBE diagnosis of autism)	sensitivity	78.57 (63.19 – 89.70)	90.74 (79.70 – 96.92)	57.45 (42.18 – 71.74)	88.89 (77.37 – 95.81)
	specificity	85.23 (78.50 – 90.51)	67.88 (59.37 – 75.60)	89.58 (83.40 – 94.05)	68.61 (60.13 – 76.27)
	PPV	60.00 (49.71 – 69.47)	52.69 (46.25 – 59.04)	64.29 (51.23 – 75.52)	52.75 (46.13 – 59.27)
	NPV	93.38 (88.74 – 96.19)	94.90 (88.90 – 97.74)	86.58 (82.16 – 90.03)	94.00 (87.96 – 97.11)
Chronological age 24 mo and younger (n=269; 67 (25%) CBE diagnosis of autism)	sensitivity	75.00 (60.40 – 86.36)	88.06 (77.82 – 94.70)	49.15 (35.89 – 62.50)	85.07 (74.26 – 92.60)
	specificity	85.97 (80.68 – 90.27)	68.32 (61.42 – 74.67)	91.90 (87.36 – 95.21)	72.28 (65.56 – 78.33)
	PPV	53.73 (44.63 – 62.59)	47.97 (42.50 – 53.48)	63.04 (50.24 – 74.24)	50.44 (44.36 - 56.51)
	NPV	94.06 (90.63 to 96.29)	94.52 (89.94 – 97.08)	86.55 (83.31 – 89.24)	93.59 (89.12 – 96.30)

CA, Childhood Autism; AA, Atypical Autism; ASD, Autism Spectrum Disorder; VR, visual reception; MSEL, Mullen Scales of Early Learning; PPV, positive predictive value; NPV, negative predictive value; CI, confidence interval

Table 9: Percent endorsement of each TASI item by diagnostic group in the initial sample.

TASI item	Autism (ASD or CA or AA)	Other Diagnosis	Typically Developing
Language Delay	37.93	27.59	6.90
1 Smile back to caregiver	12.07	8.62	1.72
2 Smile back to other	20.69	6.90	5.17
3 Response to happy	29.31	6.90	5.17
4* Response to hurt adult	63.79	51.72	53.45
5 Response to name	29.31	13.79	5.17
6 Approach to play	51.72	18.97	18.97
7 Show done/doing	63.79	53.44	29.31
8 Show interest	75.86	55.17	24.14
9 Back-and-forth talking/babbling	44.83	43.10	17.24
10 Social games	29.31	6.90	5.17
11 Look when requesting	24.14	8.62	5.17
12 Look back when showing	37.93	6.90	25.86
13 Look during physical play	17.24	3.45	3.45
14 Look during social play	10.35	0	1.72
15* Gestures	10.35	5.17	1.72
16 Gesture frequency	29.31	5.17	1.72
17 Follow point	32.76	15.52	1.72
18 Interest in children	29.31	6.90	1.72
19 Usual play	31.03	1.72	0
20 Approaching child	46.55	12.07	6.90
21 Spontaneous imitation	60.35	25.86	18.97
22 Pretend play	60.35	50.00	22.41
23 Pretend play with others	72.41	56.90	34.48
24 Inflexible play	55.17	13.79	18.97
25 Flapping	20.69	8.62	5.17
26 Repetitive hand movements	32.76	13.79	6.89
27 Rocking	22.41	13.79	8.62
28 Unusual body movements	56.90	10.35	13.79
29 Repeat vocalizations	29.31	5.17	13.79
30 Immediate echolalia	3.45	1.72	1.72
31 Delayed echolalia	8.62	0	6.90
32 Routine change	20.69	3.45	3.45
33 Minor changes	13.79	0	3.45
34 Minor, indirect changes	5.17	1.72	0
35 Impose routines	15.52	5.17	5.17
36 Strong interest	63.79	18.97	24.14
37 Atypical object	48.28	17.24	18.97
Sensory Seeking	96.55	91.38	72.41
Hyper-sensitivity	91.38	87.93	75.86
Hypo-sensitivity	91.38	91.38	75.86

ASD, Autism Spectrum Disorder; CA, Childhood Autism; AA, Atypical Autism

* item not included in algorithms

Table 10: Percent endorsement of each symptom by diagnostic group in the initial sample.

DSM-5	Autism (ASD or CA or AA)	Other Diagnosis	Typically Developing
A1: Social-emotional reciprocity	79.31	52.63	18.57
A2: Nonverbal communication	62.07	23.68	14.29
A3: Relationships	94.83	52.63	42.86
B1: Stereotyped movements	93.10	34.21	45.71
B2: Sameness/inflexibility	34.48	6.58	7.14
B3: Restricted interests	79.31	25.00	27.14
B4: Sensory differences	60.35	30.26	30.00
ICD-10	Autism (ASD or CA or AA)	Other Diagnosis	Typically Developing
1a: Integrated nonverbal communication	55.17	15.79	14.29
1b: Peer relationships	58.62	13.16	5.71
1c: Social-emotional reciprocity	63.79	25.00	14.29
1d: Spontaneous engagement-seeking	87.93	65.79	44.29
2a: Delay/lack of spoken language	37.93	21.05	5.71
2b: Conversational exchange	46.55	35.53	17.14
2c: Repetitive use of language	34.48	5.26	15.71
2d: Pretend/imitative play	74.14	48.68	31.43
3a: Encompassing preoccupation	63.79	14.47	20.00
3b: Adherence to routines or rituals	67.24	13.16	20.00
3c: Motor mannerisms	77.59	26.32	25.71
3d: Sensory/non-functional interests	72.41	19.74	27.14

ASD, Autism Spectrum Disorder; CA, Childhood Autism; AA, Atypical Autism

References

Amaral, D. G., Schumann, C. M., & Nordahl, C. W. (2008). Neuroanatomy of autism. *Trends in Neurosciences*, *31*(3), 137–145. https://doi.org/10.1016/j.tins.2007.12.005

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (5th ed.)*. Washington, D.C.

Anderson, G. M. (2015). Autism Biomarkers: Challenges, Pitfalls and Possibilities. *Journal of Autism and Developmental Disorders*. Springer New York LLC. https://doi.org/10.1007/s10803-014-2225-4

Aylward, E. H., Minshew, N. J., Field, K., Sparks, B. F., & Singh, N. (2008). Effects of age on brain volume and head. *Neurology*, 175–183.

Baio, J., Wiggins, L., Christensen, D. L., Maenner, M. J., Daniels, J., Warren, Z., … Dowling, N. F. (2018). Prevalence of Autism Spectrum Disorder Among Children Aged 8 Years — Autism and Developmental Disabilities Monitoring Network, 11 Sites, United States, 2014. *MMWR. Surveillance Summaries*, *67*(6), 1–23. https://doi.org/10.15585/mmwr.ss6706a1

Baranek, G. T. (1999). Autism during infancy: A retrospective video analysis of sensory-motor and social behaviors at 9-12 months of age. *Journal of Autism and Developmental Disorders*, *29*(3), 213–224. https://doi.org/10.1023/A:1023080005650

Barber, A. B., Wetherby, A. M., & Chambers, N. W. (2012). Brief report: Repetitive behaviors in young children with Autism spectrum disorder and developmentally similar peers: A follow up to Watt et al. (2008). *Journal of Autism and Developmental Disorders*, *42*(9), 2006–2012. https://doi.org/10.1007/s10803-011-1434-3

Barton, M. L., Robins, D. L., Jashar, D., Brennan, L., & Fein, D. (2013). Sensitivity and specificity of proposed DSM-5 criteria for autism spectrum disorder in toddlers. *Journal of Autism and Developmental Disorders*, *43*(5), 1184–1195. https://doi.org/10.1007/s10803-013-1817-8

Berkson, G., & Tupa, M. (2000). Early Development of Stereotyped and Self-Injurious Behaviors. *Journal of Early Intervention*, *23*(1), 1–19.

Bhat, A. N., Galloway, J. C., & Landa, R. J. (2010). Social and non-social visual attention patterns and associative learning in infants at risk for autism. *Journal of Child Psychology and Psychiatry*, *51*(9), 989–997. https://doi.org/10.1111/j.1469-7610.2010.02262.x

Bishop, S. L., Huerta, M., Gotham, K., Alexandra Havdahl, K., Pickles, A., Duncan, A., … Lord, C. (2017). The autism symptom interview, school-age: A brief telephone interview to identify autism spectrum disorders in 5-to-12-year-old children. *Autism Research*, *10*(1), 78–88. https://doi.org/10.1002/aur.1645

Bishop, S. L., Richler, J., & Lord, C. (2006). Association between restricted and repetitive behaviors and nonverbal IQ in children with autism spectrum disorders. *Child Neuropsychology*, *12*, 247–267. https://doi.org/10.1080/09297040600630288

Bosl, W., Tager-Flusberg, H., & Nelson, C. A. (2018). EEG Analytics for Early Detection of Autism Spectrum Disorder Risk: A data-driven approach. *Scientific Reports*, 1–20. https://doi.org/10.1038/s41598-018-24318-x

Bryson, S. E., Zwaigenbaum, L., Brian, J., Roberts, W., Szatmari, P., Rombough, V., & McDermott, C. (2007). A prospective case series of high-risk infants who developed autism. *Journal of Autism and Developmental Disorders*, *37*(1), 12–24. https://doi.org/10.1007/s10803-006-0328-2

Chakrabarti, S., & Fombonne, E. (2005). Pervasive Developmental Disorders in Preschool Children: Confirmation of High Prevalence. *Am J Psychiatry*, *162*, 1133–1141.

Charman, T., & Baird, G. (2002). Practitioner review: Diagnosis of autism spectrum disorder in 2- and 3-year-old children. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *43*(3), 289–305. https://doi.org/10.1111/1469-7610.00022

Chawarska, K., Klin, A., Paul, R., & Volkmar, F. (2007). Autism spectrum disorder in the second year: Stability and change in syndrome expression. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *48*(2), 128–138. https://doi.org/10.1111/j.1469-7610.2006.01685.x

Chlebowski, C., Robins, D. L., Barton, M. L., & Fein, D. (2013). Large-Scale Use of the Modified Checklist for Autism in Low-Risk Toddlers. *PEDIATRICS*, *131*(4), e1121–e1127. https://doi.org/10.1542/peds.2012-1525

Christensen, D. L., Maenner, M. J., Bilder, D., Constantino, J. N., Daniels, J., Durkin, M. S., … Dietz, P. (2019). Prevalence and Characteristics of Autism Spectrum Disorder Among Children Aged 4 Years — Early Autism and Developmental Disabilities Monitoring Network, Seven Sites, United States, 2010, 2012, and 2014. *MMWR. Surveillance Summaries*, *68*(2), 1–19. https://doi.org/10.15585/mmwr.ss6802a1

Constantino, J., & Gruber, C. P. (2012). *The Social Responsiveness Scale, Second Edition (SRS-2)*. Los Angeles, CA: Western Psychological Services.

Courchesne, E., Carper, R., & Akshoomoff, N. (2003). Evidence of Brain Overgrowth in the First Year of Life in Autism. *Journal of the American Medical Association*, *290*(3), 337–344. https://doi.org/10.1001/jama.290.3.337

Dawson, G., Munson, J., Webb, S. J., Nalty, T., Abbott, R., & Toth, K. (2007). Rate of Head Growth Decelerates and Symptoms Worsen in the Second Year of Life in Autism. *Biological Psychiatry*, *61*(4), 458–464. https://doi.org/10.1016/j.biopsych.2006.07.016

Dementieva, Y. A., Vance, D. D., Donnelly, S. L., Elston, L. A., Wolpert, C. M., Ravan, S. A., … Cuccaro, M. L. (2005). Accelerated head growth in early development of individuals with autism. *Pediatric Neurology*, *32*(2), 102–108. https://doi.org/10.1016/j.pediatrneurol.2004.08.005

Emerson, R. W., Adams, C., Nishino, T., Hazlett, H. C., Wolff, J. J. J. J., Zwaigenbaum, L., … Piven, J. (2017). Functional neuroimaging of high-risk 6-month-old infants predicts a diagnosis of autism at 24 months of age. *Science Translational Medicine*, *9*(393), eaag2882. https://doi.org/10.1126/scitranslmed.aag2882

Evans, D. W., Leckman, J. F., Carter, A., Reznick, J. S., Henshaw, D., King, R. A., & Pauls, D. (1997). Ritual, Habit, and Perfectionism: The prevalence and development of compulsive-like behavior in normal young children. *Child Development*, *68*(1), 58–68.

Fein, G. G. (1981). Pretend Play in Childhood : An Integrative Review. *Child Development*, *52*(4), 1095–1118.

Gilliam, J. E. (2014). *Gilliam Autism Rating Scale: GARS-3*. Pro-ed.

Granpeesheh, D., Dixon, D. R., Tarbox, J., Kaplan, A. M., & Wilke, A. E. (2009). The effects of age and treatment intensity on behavioral intervention outcomes for children with autism spectrum disorders. *Research in Autism Spectrum Disorders*, *3*(4), 1014–1022. https://doi.org/10.1016/j.rasd.2009.06.007

Hazlett, H. C., Ph, D., Gu, H., Ph, D., Munsell, B. C., Ph, D., … Ph, D. (2017). Early brain development in infants at high risk for autism spectrum disorder. *Nature*, *542*(7641), 348–351. https://doi.org/10.1038/nature21369.Early

Herlihy, L. E., Brooks, B., Dumont-Mathieu, T., Barton, M. L., Fein, D., Chen, C. M., & Robins, D. L. (2014). Standardized screening facilitates timely diagnosis of autism spectrum

disorders in a diverse sample of low-risk toddlers. *Journal of Developmental and Behavioral Pediatrics*, *35*(2), 85–92. https://doi.org/10.1097/DBP.0000000000000014

Hinnebusch, A. J., Miller, L. E., & Fein, D. A. (2017). Autism Spectrum Disorders and Low Mental Age : Diagnostic Stability and Developmental Outcomes in Early Childhood. *Journal of Autism & Developmental Disorders*, 3967–3982. https://doi.org/10.1007/s10803-017-3278-y

Huerta, M., Bishop, S. L., Duncan, A., Hus, V., & Lord, C. (2012). Application of DSM-5 criteria for autism spectrum disorder to three samples of children with DSM-IV diagnoses of pervasive developmental disorders. *American Journal of Psychiatry*, *169*(10), 1056–1064. https://doi.org/10.1176/appi.ajp.2012.12020276

Jones, W., & Klin, A. (2013). Attention to eyes is present but in decline in 2–6-month-old infants later diagnosed with autism. *Nature*, *504*(7480), 427–431. https://doi.org/10.1038/nature12715

Kim, S. H., & Lord, C. (2012a). Combining information from multiple sources for the diagnosis of autism spectrum disorders for toddlers and young preschoolers from 12 to 47 months of age. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *53*(2), 143–151. https://doi.org/10.1111/j.1469-7610.2011.02458.x

Kim, S. H., & Lord, C. (2012b). New autism diagnostic interview-revised algorithms for toddlers and young preschoolers from 12 to 47 months of age. *Journal of Autism and Developmental Disorders*, *42*, 82–93. https://doi.org/10.1007/s10803-011-1213-1

Kim, S. H., Thurm, A., Shumway, S., & Lord, C. (2013). Multisite Study of New Autism Diagnostic Interview-Revised (ADI-R) Algorithms for Toddlers and Young Preschoolers. *Journal of Autism and Developmental Disorders*, *43*(7), 1527–1538. https://doi.org/10.1007/s10803-012-1696-4

Klin, A., Lang, J., Cicchetti, D. V, & Volkmar, F. R. (2000). Brief Report : Interrater Reliability of Clinical Diagnosis and DSM-IV Criteria for Brief Report : Interrater Reliability of Clinical Diagnosis and DSM-IV Criteria for Autistic Disorder : Results of the DSM-IV Autism Field Trial. *Journal of Autism & Developmental Disorders*, *30*(2). https://doi.org/10.1023/A

Koo, T. K., & Li, M. Y. (2016). A Guideline of Selecting and Reporting Intraclass Correlation Coefficients for Reliability Research. *Journal of Chiropractic Medicine*, *15*(2), 155–163. https://doi.org/10.1016/j.jcm.2016.02.012

Lainhart, J. E. (2003). Increased rate of head growth during infancy in autism. *Journal of the American Medical Association*, *290*(3), 393–394.

Landa, R., & Garrett-Mayer, E. (2006). Development in infants with autism spectrum disorders: A prospective study. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *47*(6), 629–638. https://doi.org/10.1111/j.1469-7610.2006.01531.x

Leonard, H. C., Elsabbagh, M., Hill, E. L., Baron-Cohen, S., Bedford, R., Bolton, P., … Volein, A. (2014). Early and persistent motor difficulties in infants at-risk of developing autism spectrum disorder: A prospective study. *European Journal of Developmental Psychology*. Taylor & Francis. https://doi.org/10.1080/17405629.2013.801626

Lord, C., Luyster, R. J., Gotham, K., & Guthrie, W. (2012). *Autism Diagnostic Observation Schedule, second edition (ADOS-2) toddler module*. Los Angeles, CA: Western Psychological Services.

Lord, C., Rutter, M., Dilavore, P. C., Risi, S., Gotham, K., & Bishop, S. L. (2012). *Autism Diagnostic Observation Schedule, second edition (ADOS-2)*. Los Angeles, CA: Western

Psychological Services.
Lord, C., Storoschuk, S., Rutter, M., & Pickles, A. (1993). Using the ADI-R to diagnose autism in preschool children. *Infant Mental Health Journal*, *14*(3), 234–252.
MacDonald, R., Parry-Cruwys, D., Dupere, S., & Ahearn, W. (2014). Assessing progress and outcome of early intensive behavioral intervention for toddlers with autism. *Research in Developmental Disabilities*, *35*(12), 3632–3644. https://doi.org/10.1016/j.ridd.2014.08.036
Matson, J. L., Hattier, M. A., & Williams, L. W. (2012). How does relaxing the algorithm for autism affect DSM-V prevalence rates? *Journal of Autism and Developmental Disorders*, *42*(8), 1549–1556. https://doi.org/10.1007/s10803-012-1582-0
Matson, J. L., Kozlowski, A. M., Hattier, M. A., Horovitz, M., & Sipes, M. (2012). DSM-IV vs DSM-5 diagnostic criteria for toddlers with Autism. *Developmental Neurorehabilitation*, *15*(3), 185–190. https://doi.org/10.3109/17518423.2012.672341
McPartland, J. C., Reichow, B., & Volkmar, F. R. (2012). Sensitivity and specificity of proposed DSM-5 diagnostic criteria for autism spectrum disorder. *Journal of the American Academy of Child and Adolescent Psychiatry*, *51*(4), 368–383. https://doi.org/10.1016/j.jaac.2012.01.007
Miller, L. E., Perkins, K. A., Dai, Y. G., & Fein, D. A. (2017). Comparison of parent report and direct assessment of child skills in toddlers. *Research in Autism Spectrum Disorders*, *41–42*, 57–65. https://doi.org/10.1016/j.rasd.2017.08.002
Moore, V., & Goodson, S. (2003). How Well Does Early Diagnosis of Autism Stand the Test of Time? *Autism*, *7*(1), 47–63. https://doi.org/10.1177/1362361303007001005
Mullen, E. M. (1995). *Mullen scales of early learning manual*. Circle Pines, MN: American Guidance Service, Inc.
Orinstein, A. J., Helt, M., Troyb, E., Tyson, K. E., Barton, M. L., Eigsti, I.-M., … Fein, D. A. (2014). Intervention for Optimal Outcome in Children and Adolescents with a History of Autism. *Journal of Developmental & Behavioral Pediatrics*, *35*(4), 247–256. https://doi.org/10.1097/DBP.0000000000000037
Osterling, J., & Dawson, G. (1994). Early Recognition of Children with Autism: A Study of First Birthday Home Videotapes. *Journal of Autism & Developmental Disorders*, *24*(3).
Ozonoff, S., Iosif, A.-M., Baguio, F., Cook, I. C., Hill, M. M., Hutman, T., … Young, G. S. (2010). A Prospective Study of the Emergence of Early Behavioral Signs of Autism. *Journal of American Academy of Child and Adolescent Psychiatry*, *49*(3), 256–266.
Ozonoff, S., Macari, S., Young, G. S., Goldring, S., Thompson, M., Rogers, S. J., & J. (2008). Atypical object exploration at 12 months of age is associated with autism in a prospective sample. *Autism*, *12*(5), 457–472. https://doi.org/10.1177/1362361308096402
Paterson, S. J., Wolff, J. J., Elison, J. T., Winder-Patel, B., Zwaigenbaum, L., Estes, A., … Piven, J. (2019). The Importance of Temperament for Understanding Early Manifestations of Autism Spectrum Disorder in High-Risk Infants. *Journal of Autism and Developmental Disorders*. https://doi.org/10.1007/s10803-019-04003-2
Piven, J., Arndt, S., Bailey, J., & Andreasen, N. (1996). Regional Brain Enlargement in Autism: A Magnetic Resonance Imaging Study. *Journal of the American Academy of Child and Adolescent Psychiatry*, *35*(4), 530–536. https://doi.org/10.1097/00004583-199604000-00020
Reznick, J. S., Baranek, G. T., Reavis, S., Watson, L. R., & Crais, E. R. (2007). A parent-report instrument for identifying one-year-olds at risk for an eventual diagnosis of autism: The first year inventory. *Journal of Autism and Developmental Disorders*, *37*(9), 1691–1710.

https://doi.org/10.1007/s10803-006-0303-y
Richler, J., Bishop, S. L., Kleinke, J. R., & Lord, C. (2007). Restricted and repetitive behaviors in young children with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, *37*(1), 73–85. https://doi.org/10.1007/s10803-006-0332-6
Risi, S., Lord, C., Gotham, K., Corsello, C., Chrysler, C., Szatmari, P., … Pickles, A. (2006). Combining Information From Multiple Sources in the Diagnosis of Autism Spectrum Disorders. *Journal of American Academy of Child and Adolescent Psychiatry*, *45*(9), 1094–1103. https://doi.org/10.1097/01.chi.0000227880.42780.0e
Robins, D. L., Casagrande, K., Barton, M., Chen, C.-M. A., Dumont-Mathieu, T., & Fein, D. (2014). Validation of the Modified Checklist for Autism in Toddlers, Revised With Follow-up (M-CHAT-R/F). *Pediatrics*, *133*(1), 37–45.
Robins, D. L., Fein, D., Barton, M. L., & Green, J. A. (2001). The Modified Checklist for Autism in Toddlers: An Initial Study Investigating the Early Detection of Autism and Pervasive Developmental Disorders. *Journal of Autism and Developmental Disorders*, *31*(2), 131–144. https://doi.org/10.1023/A:1010738829569
Rogers, S. J., Vismara, L., Wagner, A. L., McCormick, C., Young, G., & Ozonoff, S. (2014). Autism Treatment in the First Year of Life: A Pilot Study of Infant Start, a Parent-Implemented Intervention for Symptomatic Infants. *Journal of Autism and Developmental Disorders*, *44*(12), 2981–2995. https://doi.org/10.1007/s10803-014-2202-y
Rutter, M., Bailey, A., & Lord, C. (2003). *Social Communication Questionnaire: Manual*. Los Angeles, CA: Western Psychological Services.
Rutter, M., LeCouteur, A., & Lord, C. (2003). *Autism Diagnostic Interview, Revised*.
Sacrey, L.-A. R., Zwaigenbaum, L., Bryson, S., Brian, J., Smith, I. M., Roberts, W., … Garon, N. (2018). Parent and clinician agreement regarding early behavioral signs in 12- and 18-month-old infants at-risk of autism spectrum disorder. *Autism Research*. https://doi.org/10.1002/aur.1920
Sánchez-García, A. B., Galindo-Villardón, P., Nieto-Librero, A. B., Martín-Rodero, H., & Robins, D. L. (2019). Toddler Screening for Autism Spectrum Disorder: A Meta-Analysis of Diagnostic Accuracy. *Journal of Autism and Developmental Disorders*. https://doi.org/10.1007/s10803-018-03865-2
Stone, W. L., Lee, E. B., Ashford, L., Brissie, J., Hepburn, S. L., Coonrod, E. E., & Weiss, B. H. (1999). Can Autism Be Diagnosed Accurately in Children Under 3 Years ? *J Child Psychol Psychiat*, *40*(2), 219–226.
Swineford, L., Guthrie, W., & Thurm, A. (2015). Convergent and Divergent Validity of the Mullen Scales of Early Learning in Young Children With and Without Autism Spectrum Disorder. *Psychol Assess*, *27*(4), 1364–1378. https://doi.org/10.1037/pas0000116
Thelen, E. (1979). Rhythmical Stereotypies in normal human infants. *Animal Behavior*, *27*(3), 699–715.
Ventola, P. E., Kleinman, J., Pandey, J., Barton, M., Allen, S., Green, J., … Fein, D. (2006). Agreement among four diagnostic instruments for autism spectrum disorders in toddlers. *Journal of Autism and Developmental Disorders*, *36*(7), 839–847. https://doi.org/10.1007/s10803-006-0128-8
Wetherby, A. M., Brosnan-Maddox, S., Peace, V., & Newton, L. (2008). Validation of the Infant-Toddler Checklist as a broadband screener for autism spectrum disorders from 9 to 24 months of age. *Autism*. https://doi.org/10.1177/1362361308094501
World Health Organization. (1993). *The ICD-10 Classification of Mental and Behavioural*

Disorders; Diagnostic criteria for research. Geneva: World Health Organization.
Zwaigenbaum, L., Bryson, S., Rogers, T., Roberts, W., Brian, J., & Szatmari, P. (2005). Behavioral manifestations of autism in the first year of life. *International Journal of Developmental Neuroscience*, *23*(2–3), 143–152. https://doi.org/10.1016/j.ijdevneu.2004.05.001

Appendix

Toddler Autism Symptom Interview (TASI)

Child's ID: _____

Chronological age: _____ If premature, weeks gestation at birth: _____

Date of birth: _____ Date of interview: _____

Respondent's relationship to child: _____

Name of person conducting interview: _____

The TASI is designed to make a judgment about the presence or absence of DSM-5 and ICD-10 autism symptoms based on caregiver report. These interview items are to be used to elicit diagnostic information from caregivers most relevant to behaviors and skills in the toddler age group. This information should be combined with other sources of information (e.g., developmental history) and clinician observation to make final best clinical estimate judgments about symptoms of ASD for toddlers *between the ages of 12 months, 0 days and 36 months, 30 days*.

Each question of the TASI corresponds to a DSM-5 or ICD-10 symptom (American Psychiatric Association, 2013, World Health Organization, 2004). Questions are organized into sections based on the DSM-5 diagnosis and ask about ways in which a toddler might display each symptom. There is a suggested algorithm for each DSM-5 and ICD-10 symptom with cutoffs for each autism criterion. These algorithms should be combined with clinical judgment for diagnostic decisions. Some additional questions are not included in algorithm scoring; these can be used for clinical purposes or other data analyses. Therefore, the examiner should obtain examples for appropriate items.

General administration and scoring directions: For each item, the clinician should ask the question to the caregiver, then select a score of 0 or 1 based on the options provided (0=typical development, 1=ASD indication). The examiner should obtain examples of child behavior for appropriate items. If the caregiver responds with multiple options, try to determine which behavior is most *typical*, and score using that behavior. Some items (e.g, items 4, 15) are not assigned a score but should still be included in the interview.

After completing the TASI interview, a scorer should sum the columns on each page, filling in the numbered boxes at the bottom of each page. Some pages (e.g., page 5, 7, 10, 13) have more than one box – each box should be a sum of the items above it not already included in another box sum. Special scoring instructions are included for page 9. The values in these numbered boxes should then be transcribed to the scoring algorithm document.

For many items, the behavior is expected of any child approaching or past the first birthday (e.g., noticing and imitating other's obvious positive affect, making eye contact, responding to their name being called). For a child who does not show these behaviors, or shows them rarely, these should be

coded with a (1). In a few cases, a more advanced developmental level is required in order to expect the behavior (e.g., pretend play, active play with another child, combining words into phrases). If your judgment is that the child is functioning overall at a developmental level that would allow the behavior (e.g., simple pretend play), then the absence of that behavior should be scored (1). But if you judge that the child's developmental cognitive and language level is 6-9 months, then pretend play is not expected and would not warrant a score of (1). "N/A" or "consistent with developmental level" should be selected; these options are included for relevant items. If no such option is included, then judge the behavior against the child's chronological age.

For questions regarding social behaviors, it is important to probe for both the consistency with which the child demonstrates each behavior across people and settings, and the amount of effort required on the part of the adult to elicit the behavior. If a communicative or social behavior is in the child's repertoire, but it is displayed rarely, and/or an adult must work harder than would be expected to get the child to demonstrate the behavior, then score it as "rarely". One exception to this rule is if the child has mastered a task (e.g., marking with a pencil on paper, saying "a b c d e") and the child does not want to display this skill to another adult and refuses or acts shy; this is typical toddler behavior.

When listed options are presented on the form, the examiner should check off examples endorsed by caregivers as well as record any examples not included on the form. When caregivers provide an example of behavior that is not on the form, the clinician should use his/her judgment as to whether this behavior indicates the child is acquiring the skill as expected for his/her developmental level, or is displaying a symptom possibly indicative of autism.

It is not necessary to ask questions verbatim. More important is ensuring that the caregiver understands the question. If the behavior in question has already been discussed, record the answer and reconfirm only if you feel it is necessary. If the caregiver does not understand the intent of the question, give an example or rephrase the question. Refer to the accompanying scoring manual for scoring assistance and some examples.

In many cases, interviews like the TASI are conducted simultaneously as the child engages in other testing. Thus, the interviewer may observe behaviors that clearly contradict caregiver report. If this occurs, discuss this discrepancy with the caregiver, and use the caregiver's input after discussion to make a scoring determination. This discrepancy should be noted.

As much as possible, clinicians should use the child's name rather than referring to him or her as "your child" and should use the gender appropriate pronoun.

American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders (5th ed.). Arlington, VA

World Health Organization. (2004). ICD-10: International statistical classification of diseases and related health problems: tenth revision, 2nd ed. World Health Organization.

Introductory Language Questions	
i. Does your child use words to communicate? Yes: continue No: skip to item vi. & vii.	
ii. How many different words (that are understandable to familiar adults) does your child use to communicate during a typical day? *(If necessary, help caregivers by suggesting categories like people, foods, clothes, and animals; make sure these are words the child says, not just appears to understand)* 1-5 words 6-10 words or 11-30 words >30 words Examples: _____	
iii. When did he/she start using single words? 1: older than 24 months 0: younger than 24 months or N/A	
iv. Does your child put together two-word combinations on a daily basis? 1: No 0: Yes or N/A	
v. How many different phrases (that are understandable to familiar adults) does your child use to communicate? *("mommy go," "night-night baby," "more bubbles;" whereas "more juice," "more ball," "more cookie" would NOT be counted as three separate phrases)*. 1-5 phrases 6-10 phrases or 11-30 phrases >30 phrases Examples: _____	
vi. Does your child ever mime or use gestures to communicate with you when he/she doesn't know the word?	
vii. *Clinician*: *Given the above responses and the child's developmental level, is there evidence of abnormalities in communication that are not compensated for through gesture or miming?* 1: Yes, abnormalities are present 0: No, language development appears typical or appropriately compensated for	0 / 1

box 1

DSM-5 A. Persistent deficits in social communication and social interaction across multiple contexts, as manifested by the following, currently or by history (examples are illustrative, not exhaustive):	
A1. Deficits in social-emotional reciprocity, ranging, for example, from abnormal social approach and failure of normal back-and-forth conversation; to reduced sharing of interests, emotions, or affect; to failure to initiate or respond to social interactions.	
1. When you smile at your child, how often does he/she smile back? Sometimes/Often Rarely/Never 0 1	0 / 1
2. When another familiar adult or caregiver smiles at your child, how often does he/she smile back? Sometimes/Often Rarely/Never 0 1	0 / 1
3. If your child sees other people around him/her being happy (e.g., at a birthday party), how often does he/she appear to notice and share those feelings (e.g., smiling, clapping, etc.)? Sometimes/Often Rarely/Never 0 1	0 / 1
4. How is your child <u>most likely to respond</u> if he/she sees you or another familiar adult hurt or sad? Does not notice Covers his/her ears Laughs Looks (at child or at caregiver) but does not respond or appear distressed Cries Looks distressed Gets another adult for help Offers comfort (e.g., pats/hugs you, gets a band-aid, shares a comfort item) Comes over/approaches you Says "crying" or labels the distress Other: _____	
5. How often does your child respond when you call his/her name? Sometimes/Often Rarely/Never 0 1 ↓ How does your child usually respond? __ Looks towards you when you call his/her name __Vocalizes when you call his/her name __Both looks towards you and vocalizes when you call his/her name __Other: _____	0 / 1

box 2

6. How often does your child approach other people to play or interact? 0 / 1

Sometimes/Often 0 Rarely/Never 1

7. How often does he/she show you things he/she has done or is doing (e.g., a picture or scribble he/she drew, a puzzle he/she completed)? 0 / 1

Sometimes/Often 0 Rarely/Never 1

8. How often does your child try to get you to look at things that interest him/her *(e.g., airplanes, trucks, trains, cute animals)*, just for the purpose of sharing, not because he/she wants something or needs help? 0 / 1

Sometimes/Often ↓ Rarely/Never 1

How does he/she typically do that?

(Examiner should read and check each choice that the caregiver endorses as typical for the child. Circle WITH or WITHOUT eye contact (e.c.) as appropriate. Get examples as necessary to be sure caregiver interprets the item as intended. Eye contact in this context is when child checks to see if caregiver is looking at the right thing. ***Score lowest- if caregiver reports any 0-point behavior, score 0****.)*

1: Reaches toward or touches objects (WITH/WITHOUT e.c.)

0: Brings you an object to show (WITH/WITHOUT e.c.)

Points to objects (WITH/WITHOUT e.c.)

Holds up objects for you to see (WITH/WITHOUT e.c.) *(e.g., a flower, a scribble, an interesting toy)*

Vocalizes to express his/her interest with clear intent (WITH/WITHOUT e.c.) *(e.g., saying "bu-bu" as you blow bubbles)*

Uses words (WITH/WITHOUT e.c.) *(e.g., "look!", "doggy!")*

Other: _____

box 3

9. *If child does not yet use words:* How often does your child engage in back-and-forth babbling (e.g., babbling back when you direct a vocalization to him/her)? 0 / 1

Sometimes/Often 0 Rarely/Never 1

If child uses words: How often can you have a short conversation with your child? That is, the child takes two back and forth turns, NOT repetitively asking the same question or only repeating what you say, or ignoring what you say?

Sometimes/Often 0 Rarely/Never 1

box 4

10. Does your child enjoy social games such as peek-a-boo, pat-a-cake, Ring around the Rosie, etc.? Sometimes/Often → Does he/she actively do something to get you to play or continue the game? Yes: 0 No: 1 ↓ What does he/she do? _____	0 / 1

box 5

A2. Deficits in nonverbal communicative behaviors used for social interaction, ranging, for example, from poorly integrated verbal and nonverbal communication; to abnormalities in eye contact and body language or deficits in understanding and use of gestures; to a total lack of facial expressions and nonverbal communication.

11. How often does your child look at you when making a request? 0 / 1

Sometimes/Often 0 Rarely/Never 1

12. When your child is trying to get you to look at something, does he/she look back at you to see if you are looking at the same thing? 0 / 1

Sometimes/Often 0 Rarely/Never 1

13. How often does your child look at you during *physical* play (e.g. roughhousing or tickling)? 0 / 1

Sometimes/Often 0 Rarely/Never 1

14. How often does your child look at you during *social* play (e.g., singing a song, playing peek-a-boo)? 0 / 1

Sometimes/Often 0 Rarely/Never 1

15. What gestures does your child use? *(Examiner should read options and ask caregiver to respond for each example. Check all that caregiver endorses. Get examples if necessary.)*

__Nods yes No gestures
__Shakes head "no"
__Waves "hi" and "bye-bye"
__Claps hands
__Blows a kiss
__Points
__Other:_____

16. How often does your child use these gestures? *(If child has no gestures, score 1)* 0 / 1

Sometimes/Often 0 Rarely/Never 1

↓

How often does your child look at you while using these gestures?

Sometimes/Often 0 Rarely/Never 1

box 6

17. If you point at something and say, "Look," how often does your child look at the object? 0 / 1

Sometimes/Often 0 Rarely/Never 1

box 7

## How often does your child look towards a stranger or less familiar adult when that adult is speaking to them? Sometimes/Often 0 Rarely/Never 1	

A3. Deficits in developing, maintaining, and understanding relationships, ranging, for example, from difficulties adjusting behavior to suit various social contexts; to difficulties in sharing imaginative play or in making friends, to absence of interest in peers.	
18. How often does your child seem interested in other children? Sometimes/Often 0 Rarely/Never 1	0 / 1
19. When you are at the playground or the park and other children are around, how does your child <u>usually</u> play? *(Let caregiver respond, then examiner should evaluate relevant options. Check all that caregiver endorses, and select the score for the child's usual behavior. Get examples if necessary.)* 1: __Ignores other children 0: __Child has limited opportunity to play with other children __Caregiver has limited opportunity to observe child with other children __Watches other children __Plays near other children *(wants to be near the children themselves, not just because the children have a preferred toy or are doing a preferred activity)* __Follows other children __Approaches other children Other:_____	0 / 1
20. When another child approaches your child to play, how does your child <u>usually</u> respond? *(Let caregiver respond, then examiner should evaluate relevant options. Check all that caregiver endorses, and select the score for the child's usual behavior. Get examples if necessary.)* 1: __Ignores the child __Runs to caregiver or other adult __Pushes child away __Moves away from child 0: __ Child has limited opportunity to play with other children __ Caregiver has limited opportunity to observe child with other children __ Engages in play (verbal and physical) __ Engages in play (physical only) Other:_____	0 / 1

box 8

21. How often does your child spontaneously imitate the actions of others without verbal or physical prompting if these are: *(score lowest)* Your actions? Sometimes/Often 0 Rarely/Never 1 Actions of siblings or other children? Sometimes/Often 0 Rarely/Never 1 Actions of other adults? Sometimes/Often 0 Rarely/Never 1	0 / 1	0 / 1
22. How often does your child engage in pretend play (e.g., pretending to feed a doll, pretending to drink out of a cup, pretending to fly a toy airplane)? Sometimes/Often ↓ Rarely/Never 1 How does your child usually do this? 1: __Pretends only when shown an example or otherwise prompted __Some repetitive pretend play (i.e., small number of play scenes re-enacted over and over) __Some spontaneous pretend play but only what's been taught 0: __Pretend play just beginning, and/or consistent with developmental level __Simple spontaneous and creative pretend play __Sophisticated spontaneous and creative pretend play Example(s) of play :_____		0 / 1
23. If your child does pretend play, does he/she do this with other children, with adults, or only with him/herself? 1: __Does not yet play pretend __Mostly by him/herself 0: __ N/A; no pretend play, but consistent with developmental level __Will actively engage in pretend with an adult __Will actively engage in pretend with a sibling __Will actively engage in pretend with another child (not a sibling) Other:_____	0 / 1	

**scoring note: sum columns for box 9 and box 10 separately, such that box 9 is a sum of items 21 and 23, while box 10 is a sum of item 21 and 22.*

box 9	box 10

B. Restricted, repetitive patterns of behavior, interests, or activities, as manifested by at least two of the following, currently or by history (examples are illustrative, not exhaustive)

B1. Stereotyped or repetitive motor movements, use of objects, or speech (e.g., simple motor stereotypies, lining up toys or flipping objects, echolalia, idiosyncratic phrases).

24. How often does your child play with his/her toys in a specific, inflexible or repetitive way (e.g., lining up toys or objects in the same way each time, putting Legos together only in one specific pattern)? 0 / 1

Sometimes/Often → 1↓ | Rarely/Never → 0

Can your child be easily redirected from this kind of play?

Yes | No

Example(s) : _____

box 11

25. Does your child flap his/her arms and/or hands? 0 / 1

0: __No 0: __Yes, flaps only when excited

1: __Yes, flaps at other times, such as when alone

26. How often does your child make unusual or repetitive movements with his/her hands or fingers? (e.g., splaying out or stiffening fingers or twisting fingers in unusual ways, splaying out arms/hands, tensing*; Demonstrate if respondent is uncertain what you are referencing.)* 0 / 1

Sometimes/Often → 1 ↓ | Rarely/Never → 0

Does your child move his/her fingers, hands, and/or objects near his/her face or eyes in an unusual way? Examples: _____

27. How often does your child rock back and forth? 0 / 1

Sometimes/Often → ↓ | Rarely/Never → 0

When does he/she do this?

Circle one:

0: __Mainly when tired or upset (to self-soothe)

1: __At other times. Describe: _____

__Appears unusual but can be redirected

__Appears unusual and can be hard to interrupt

28. How often does your child engage in unusual movements with his/her body (e.g., walking on his/her toes, jumping repeatedly, spinning, pacing, bouncing from foot to foot, tensing whole body, etc.)? 0 / 1

Sometimes/Often → ↓ | Rarely/Never → 0

0: Normal for developmental age

1: Yes, appears unusual but can be redirected

1: Yes, appears unusual and can be hard to interrupt

Example: _____

box 12

29. How often does your child make repeated vocalizations or unusual sounds that are not real words? (e.g., screeching and repetitive sounds like "ticka ticka ticka"; not meaningful word approximations) Sometimes/Often → Rarely/Never 0 What is the purpose of these sounds? 0: Mostly to interact or communicate with others 1: Mostly for the child's own enjoyment	0 / 1
30. How often does your child repeat what you say (immediate echolalia; e.g., saying "You want a cookie" after being asked "Do you want a cookie" and saying "truck" immediately after hearing "Daddy drives a truck")? *(If child has no words, score 0)* Sometimes/Often → Rarely/Never 0 How often does it appear to be primarily used in a communicative manner (e.g., repeating "juice" after being asked "Do you want juice?" only when desiring juice)? Sometimes/Often 0 Rarely/Never 1	0 / 1
31. How often does your child repeat phrases, conversations, or lines that he/she has heard from shows, movies, songs or books, etc. (delayed echolalia)? *(If child has no words, score 0)* Sometimes/Often → Rarely/Never 0 Are they repeated in the exact same way (i.e., same intonation or accent) that your child heard them? Sometimes/Often 1 Rarely/Never 0	0 / 1

box 13

B2. Insistence on sameness, inflexible adherence to routines, or ritualized patterns or verbal/nonverbal behavior (e.g., extreme distress at small changes, difficulties with transitions, rigid thinking patterns, greeting rituals, need to take same route or eat same food every day).	
32. Does your child become distressed if activities or conversations are not done the same way each time (e.g., insists that a caregiver says a phrase in the same way every time, becomes distressed if caregiver takes alternate route home in the car, distressed by change in daycare routine)? Sometimes/Often ↓ Rarely/Never 0 0: Normal for developmental level 1: Unusual for developmental level and/or mildly disruptive 1: Significantly disruptive to child and/or family	0 / 1
33. Does your child become distressed or upset if there are minor changes in his/her immediate environment (e.g., getting new sheets for his/her bed, changing from shorts to long pants in autumn)? Sometimes/Often ↓ Rarely/Never 0 0: Normal for developmental level 1: Unusual for developmental level and/or mildly disruptive 1: Significantly disruptive to child and/or family	0 / 1
34. Does your child become distressed or upset if minor changes occur in his/her environment that don't directly affect him/her (e.g., changing the color of your living room, a caregiver with a new hairstyle or new glasses)? Sometimes/Often ↓ Rarely/Never 0 0: __Normal for developmental level 1: __Unusual for developmental level and/or mildly disruptive 1: __ Significantly disruptive to child and/or family	0 / 1
35. Does your child try to impose his/her routines or rituals on others (e.g., moving a sibling's toy cars so that they are in a specific pattern, requiring all who come into your house to remove hats)? Sometimes/Often ↓ Rarely/Never 0 0: Normal for developmental level 1: Unusual for developmental level and/or mildly disruptive 1: Significantly disruptive to child and/or family	0 / 1

box 14

B3. Highly restricted, fixated interests that are abnormal in intensity or focus (e.g., strong attachment to or preoccupation with unusual objects, excessively circumscribed or perseverative interest)

36. Is there anything that your child is interested in that seems like all he/she wants to do? 0 / 1

Yes No

1 ↓ 0

How does your child react if you attempt to distract him/her or remove the object?

__Mild interests, easily distractible, or not very distressed

__ Strong interests, hard to distract, or very distressed

Describe the interests:_____

box 15

37. Does your child enjoy carrying around or playing with items that differ from most children his/her age (e.g., toilets, hubcaps, lights, spinning objects, vacuum cleaners, string, tools such as pliers, keys, soup cans, hairbrushes, etc.)? 0 / 1

Yes No

1 ↓ 0

How does your child react if you attempt to distract him/her or remove the object?

__ Mild interests, easily distractible, or not very distressed

__ Strong interests, hard to distract, or very distressed

Describe the interests:_____

box 16

B4. Hyper- or hypo-reactivity to sensory input or unusual interests in sensory aspects of the environment (e.g., apparent indifference to pain/temperature, adverse response to specific sounds or textures, excessive smelling or touching of objects, visual fascination with lights or movement).

38. Does your child…

	Sensory Seeking	Hyper-Sensitivity	Hypo-Sensitivity
VISUAL	__look out of the corners of his/her eyes __like to squint at things __look along straight lines or lines of toys __get down on the floor to look at toys at eye-level __stare at movie credits __seem unusually fixated on shiny or moving objects like fans, water, shadows, or bright lights __dangle shoelaces or string and watch __spin toy car wheels and watch __play with eyes or hair on toy doll	__dislike bright lights inside or outside	__not seem to notice things he/she sees
TACTILE	__(repeatedly) touch things with different textures, such as textured walls, smooth objects, carpet, squishy toys	__avoid touching things with a certain texture, such as textured walls, smooth objects, carpet, squishy toys __dislike wearing certain clothing *(how does the clothing feel?)* __dislike or pull away when being cuddled or held __dislike being groomed (e.g., bath-time, having face washed, fingernails cut, hair brushed/cut	__not react to touch __ reacts to painful stimuli less than would be expected __accepts bathwater that you might think is too hot/cold
AUDITORY	__play toys with sounds over and over, seemingly to listen to a certain sound(s)	__startle easily or cover his/her ears when hearing certain sounds (e.g., toilet flushing, vacuum, baby crying) __notice sounds before other children do (e.g., planes, trains, sirens from far away, dripping tap, buzzing sounds from a lamp)	__ignore or tune out loud noises (e.g. doesn't react to alarms, vacuum, loud object crashing to floor)
SMELL & TASTE	__smell objects not meant to be smelled; smell people __stuffs food into his/her mouth	__refuse to eat certain foods because of the texture: _____ __ vomits or gags when sees/smells a specific food __avoids people with a certain smell (e.g., perfume) __insist that food be a certain temperature (e.g., always hot, always cold, always room temperature)	

Note any other sensory behaviors here (*Include in sum below if behaviors indicate sensory seeking or hypo/hyper sensitivities*): _____

Sensory Seeking: box 17 Hyper-sensitivity: box 18 Hypo-sensitivity: box 19

Regression Questions

Has your child lost any skills that he/she had previously mastered?

Yes No

What skill(s) was lost. (Check all that apply.)

__Speech and language
__Gestures or nonverbal communication
__Eye contact or social interaction
__Cognitive skills (e.g., puzzle making)
__Fine motor skills
__Gross motor skills

__Other:_____

Did the loss occur after an illness or other identifiable event?

Yes No

Describe:_____

How old was the child at the time he/she lost skill(s)?_____

How long had the child mastered the skill(s) before the loss? _____

How long after the loss until he/she started to regain the skill(s)?_____

What skills were lost? _____

If there was a loss of speech or language, how much did he/she have prior to losing skills?

__Words
Example(s):_____
__Phrases
Example(s):_____
__Sentences
Example(s):_____

Conclusion

Is there anything that I didn't specifically ask about that you would like to share with us about your child? Perhaps there is something that he/she does that you, other family members, friends, or service providers have noticed and been puzzled or concerned about:

_____
_____
_____

TASI Scoring Document Instructions

This tool allows for the scoring of the TASI interview form, enabling a clinician to determine the presence or absence of each DSM-5 and ICD-10 symptom. DSM-5 Autism Spectrum Disorder (ASD), DSM-5 Relaxed ASD[1], ICD-10 Childhood Autism (CA), and ICD-10 Atypical Autism (AA) algorithms are included here.

Step 1: Transfer scores from each box on TASI interview form to the table below.

Step 2: The accompanying scoring form has 2 pages – one for DSM-5 and one for ICD-10. On the scoring form, copy the box scores into each square and calculate sums. Record a check in the diamond for each symptom if the sum is large enough.

Step 3: At the bottom of each side are the requirements for diagnosis – record whether the child meets criteria for each diagnosis.

BOX #	Score
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	

[1] Barton, M. L., Robins, D. L., Jashar, D., Brennan, L., & Fein, D. (2013). Sensitivity and specificity of proposed DSM-5 criteria for autism spectrum disorder in toddlers. *Journal of Autism and Developmental Disorders*, *43*(5), 1184–1195. http://doi.org/10.1007/s10803-013-1817-8

DSM-5 A1: Social Emotional Reciprocity

☐ box 2 + ☐ box 3 + ☐ box 4 + ☐ box 5 = ☐

If sum is larger than 1, check here: ◇ A1

DSM-5 A2: Nonverbal Communication

☐ box 6 + ☐ box 7 = ☐

If sum is larger than 0, check here: ◇ A2

DSM-5 A3: Relationships

☐ box 8 + ☐ box 9 = ☐

If sum is larger than 0, check here: ◇ A3

DSM-5 B1: Repetitive movements, object use, speech

☐ box 11 + ☐ box 12 + ☐ box 13 = ☐

If sum is larger than 0, check here: ◇ B1

DSM-5 B2: Insistence on sameness

☐ box 14 = ☐

If sum is larger than 0, check here: ◇ B2

DSM-5 B3: Restricted or fixated interests

☐ box 15 + ☐ box 16 = ☐

If sum is larger than 0, check here: ◇ B3

DSM-5 B4: Sensory symptoms

☐ box 17 + ☐ box 18 + ☐ box 19 = ☐

If sum is larger than 0, check here: ◇ B4

To meet DSM-5 ASD criteria, child must demonstrate:

☐ 3 out of 3 A symptoms: Does child meet DSM-5 ASD criteria? _____

☐ 2 out of 4 B symptoms:

To meet relaxed DSM-5 Relaxed ASD criteria[1], child must demonstrate:

☐ 2 out of 3 A symptoms: Does child meet relaxed criteria? _____

☐ 1 out of 4 B symptoms:

ICD-10 Cluster B1: Reciprocal social interaction

a: Integrated nonverbal communication

box 6 = ☐

If sum is larger than 0, check here: 1a ◇

b: Peer relationships

box 8 = ☐

If sum is larger than 0, check here: 1b ◇

c: Socio-emotional reciprocity

box 2 + box 5 = ☐

If sum is larger than 0, check here: 1c ◇

d: Spontaneous engagement seeking

box 3 + box 7 = ☐

If sum is larger than 0, check here: 1d ◇

ICD-10 Cluster B2: Communication

a: Delay/lack spoken language

box 1 = ☐

If sum is larger than 0, check here: 2a ◇

b: Conversational exchange

box 4 = ☐

If sum is larger than 0, check here: 2b ◇

c: Repetitive use of language

box 13 = ☐

If sum is larger than 0, check here: 2c ◇

d: Pretend/imitative play

box 10 = ☐

If sum is larger than 0, check here: 2d ◇

ICD-10 Cluster B3: Restricted, repetitive, stereotyped patterns of behavior

a: Encompassing preoccupation

box 15 = ☐

If sum is larger than 0, check here: 3a ◇

b: Adherence to routines or rituals

box 11 + box 14 = ☐

If sum is larger than 0, check here: 3b ◇

c: Motor mannerisms

box 12 = ☐

If sum is larger than 0, check here: 3c ◇

d: Sensory/non-functional interests

box 16 + box 17 = ☐

If sum is larger than 0, check here: 3d ◇

To meet ICD-10 Childhood Autism criteria, child must demonstrate:

☐ 2 symptoms in cluster B1 Does child meet ICD-10 CA criteria? _____

☐ 1 symptom in cluster B2

☐ 1 symptom in cluster B3

☐ At least 6 symptoms combined in clusters B1, B2, and B3.

To meet ICD-10 Atypical Autism criteria, child must demonstrate:

☐ 1 symptom in cluster B1 Does child meet ICD-10 AA criteria? _____

☐ 1 symptom in cluster B2

☐ 1 symptom in cluster B3

TASI Scoring Manual

This document is to be used in conjunction with the TASI interview form, which also has some general directions. The TASI is scored item by item; each item may be suggestive of a developmental problem (score = 1) or be consistent with typical development (score = 0). While in some cases the presence of a behavior (e.g., eye contact) is typical, in other cases the presence of a behavior (e.g., hand flapping) is atypical. While the TASI is an interview form to be used with the child's primary caregiver, scoring the TASI requires the clinician to employ clinical judgment in interpreting caregiver's responses and descriptions. Often, developmental evaluations are conducted so that the child participates in testing while the caregiver responds to interview questions. In such a case, the interviewer may notice discrepancies between what the caregiver reports and their own observations. While it is appropriate to refer to the child's observed behaviors (e.g, "I'm hearing him make a lot of different sounds") and engage in a discussion of these behaviors with the caregiver, the TASI should be scored based on caregiver report combined with clinician judgment of the caregiver's descriptions of behaviors, not on the clinician's own observation.

Due to the importance of clinical judgement in administering and scoring the TASI interview, the interviewer should have significant training and experience in early typical and atypical child development, diagnosis of autism and other developmental disorders in young children, and experience in clinical interviewing.

The TASI assesses a wide range of child behaviors. Some of these are behaviors that are easy for caregivers to notice in everyday life (e.g., presence or absence of eye contact). Others may occur less frequently (e.g., hand flapping) or be harder to judge (e.g., pointing to share attention but not to request) For this reason, cutoffs for differentiating between "sometimes" and "rarely" depend a great deal on the behavior involved. Some general guidelines are:

- if the behavior occurs about as often as would be expected in a typical toddler in appropriate contexts, even if a toddler were distractible, shy, or somewhat oppositional, then score as sometimes/often.
- if the behavior occurs only in a few infrequent situations, or noticeably less often than would be expected even for a temperamental toddler, then score as rarely/never.

- -

Introductory Language Questions (p. 3)

These questions are designed to assess whether the child's language is significantly delayed and whether the child shows a lack of communicative drive. If a caregiver reports that the child does not use words, it is important to assess if this is due to a language delay or because the child is not interested in communicating.

i. Does your child use words to communicate?

ii. How many different words does your child use to communicate during a typical day?

iii. When did he/she start using single words?
Notes: For children under age 24 months, do not score.

iv. Does your child put together two-word combinations on a daily basis?
Notes: These should be flexible two-word phrases, such as "more juice" and "more tickle", not only overlearned phrases such as "oh no" or "bye bye".

v. How many different phrases does your child use to communicate?

vi. Does your child ever mime or use gestures to communicate with you when he/she doesn't know the word?
Notes: This question is directed at whether the child uses gestures including reaching and pointing to communicate his needs when he doesn't know the word he needs. Gestures used to request or to show are to be coded here. Gestures including waving or blowing a kiss are coded in question 15. Some caregivers may indicate here that the child does not use gestures and, later in the interview, endorse certain gestures. This is fine and item vi. should not be revised.

If the caregiver affirms that the child has gestures, the interviewer should ask about when those gestures are used and what they look like.

vii. *Clinician*: *Given the above responses and the child's developmental level, is there evidence of abnormalities in communication that are not compensated for through gesture or miming?*
Notes: This item is scored as the clinician's judgment as to whether the child appears to have a lack of communicative intent.

1. When you smile at your child, how often does he/she smile back?
Notes: This question addresses whether the child smiles in response to their primary caregiver. If a secondary caregiver is being interviewed using the TASI, rephrase as "When your child's mother/grandmother/father/etc. smiles at him/her, how often does he/she smile back?"

2. When another familiar adult or caregiver smiles at your child, how often does he/she smile back?
Notes: This question should help the clinician determine if the child smiles in response to more than one adult they are comfortable with. Smiling in response to strangers or unfamiliar adults should not be coded here.

Useful examples:
"If your child's grandmother/father/babysitter smiles at the child, how would your child respond?"

3. If your child sees other people around him/her being happy (e.g., at a birthday party), how often does he/she appear to notice and share those feelings (e.g., smiling, clapping, etc.)?
Notes: This behavior should be seen with more than just one person. If the child notices and shares a sibling's feelings *only*, score as rarely/never (1).

Useful examples:
"If you and your child were at a birthday party or family gathering, how would your child look and act – scared and apprehensive, or joyful? Would he know you were at a happy event?"

4. How is your child <u>most likely to respond</u> if he/she sees you or another familiar adult hurt or sad?
Notes: If a caregiver says they don't know, ask them to picture a situation and consider what they think is the child's most likely response.

Useful examples:
"If you stubbed your toe and said "ouch," how would your child respond?"

5. How often does your child respond when you call his/her name?
Notes: It is important to assess whether the child responds *even* when playing with preferred toys. It is typical for children not to respond to their name when playing with their favorite toys, but it is atypical for a child to be entirely impossible to engage. If this is the case, assess how frequently the child is "too absorbed" in an activity to respond to his/her name being called. If it is with a majority of activities, then score as rarely/never (1). If the child is able to respond to his/her name in all but one or two highly preferred activities, but then does respond after their name is called several times, then score as sometimes/often (0). If the child usually responds to hearing his/her name called once or twice, score as sometimes/often (0). If the caregiver must usually call the child's name multiple times to catch his/her attention, no matter what he/she is doing, score as rarely/never (1).

6. How often does your child approach other people to play or interact?
Notes: This question is to determine if the child seeks out people to engage with. If the child only approaches others to give them objects for help, to be near them, or to get rid of the object, but does not seek to play or interact with them, this item should be scored as rarely/never (1).

7. How often does he/she show you things he/she has done or is doing (e.g., a picture or scribble he/she drew, a puzzle he/she completed)?
Notes: This item is targeted to whether the child shows the caregiver things she has done or is proud of, not just something she finds interesting (code this in question 8). If the child hands things to the caregiver, but these are not things the child is proud of, or it seems in fact as though the child is just trying to get rid of them or needs help with them, do not include in this code.

Useful Examples:
"If your child stacks some blocks or completes a puzzle, will he do something to show you what he has done?

8. How often does your child try to get you to look at things that interest him/her *(e.g., airplanes, trucks, trains, cute animals)*, just for the purpose of sharing, not because he/she wants something or needs help?
Notes: This item is scored based on whether the child directs an adult's attention to share their interest in a preferred item, object, or activity (even if it is a special interest). Determine what a child usually does when they see something they're particularly interested in.

Useful examples:
"If your child saw a fire truck or something he was really excited about, but was not requesting something, what would he do? Would he do anything to show you?"

9. *If child does not yet use words:* How often does your child engage in back-and-forth babbling (e.g., babbling back when you direct a vocalization to him/her)?

***If child uses words:* How often can you have a short conversation with your child? That is, the child takes two back and forth turns, NOT repetitively asking the same question or only repeating what you say, or ignoring what you say?**

Notes: It is important to first clarify that this question is applicable regardless of the child's language level. If a child is nonverbal but babbles, then describe, or even act out, for the caregiver exactly what a back-and-forth babbling conversation may look like.

Useful examples:
"I know you said that CHILD doesn't use words, but he does make some sounds. Do you ever have "conversations" with him, where you say something, and then he responds with babbling, and you respond, and he replies?"

10. Does your child enjoy social games such as peek-a-boo, pat-a-cake, Ring around the Rosie, etc.?

Notes: First, ask the caregiver if the child enjoys any social games or social routines, and identify a preferred activity, if one exists. Then, ask the caregiver whether the child does anything to continue or initiate the social game.

A score of Yes (0) indicates that the child employs an active strategy to request that the activity continue, which may include vocalizations, eye contact, gestures, or movements (i.e., the child hides his face to request that peek-a-boo continue). If a child simply becomes fussy in a way that is undirected, code as No (1).

11. How often does your child look at you when making a request?

Notes:

Useful examples:
"What if your child is requesting something, by pointing, vocalizing, reaching, etc., and he does not get what he wants right away, does he look back at you or make eye contact with you, while continuing to request?"

12. When your child is trying to get you to look at something, does he/she look back at you to see if you are looking at the same thing?

Notes:

Useful Examples:
"When your child is drawing your attention to something interesting (whether she wants help or not, does she look back to see if you are looking at the thing she is indicating?"

13. How often does your child look at you during *physical* play (e.g. roughhousing or tickling)?

Notes: It is important to differentiate the child's level of eye contact during physical vs. social play. The interviewer should determine some examples of physical and social play that the child engages in and ask the caregiver how often the child looks at them during each.

14. How often does your child look at you during *social* play (e.g., singing a song, playing peek-a-boo)?
Notes: It is important to differentiate the child's level of eye contact during physical vs. social play. The interviewer should determine some examples of physical and social play that the child engages in and ask the caregiver how often the child looks at them during each.

15. What gestures does your child use? ***(Examiner should read options and ask caregiver to respond for each example. Check all that caregiver endorses. Get examples if necessary.)***
Notes: In order to score as asymptomatic (0), a child must demonstrate at least one gesture independently.

If the child only demonstrates a gesture immediately in response to another person's demonstration of the gesture (imitation), note this but do not modify the score.

16. How often does your child use these gestures? ***(If child has no gestures, score 1)***
How often does your child look at you while using these gestures?
Notes: If the child uses at least one gesture sometimes (at least once/day) with eye contact, score based on that gesture.

17. If you point at something and say, "Look," how often does your child look at the object?
Notes: It can be helpful to demonstrate this for caregivers. When the adult has the child's attention, points at something, and says 'look', if the child makes an attempt to visually find the object being pointed toward at least half the time, score as sometimes/often (0). If the child does not make an attempt to find the object half the time, or is very inefficient in doing this (looks only vaguely in the right direction but is not accurate in finding the object) score rarely/never (1).

18. How often does your child seem interested in other children?
Notes: This item aims to determine if the child shows interest in other children, beyond simply interest in the toy held by another child or another child's activity. In order to score sometimes/often (0), the child should show interest in children who are not siblings. If a child only shows interest in a sibling, score as rarely/never (1).

19. When you are at the playground or the park and other children are around, how does your child <u>usually</u> play? ***(Let caregiver respond, then examiner should evaluate relevant options. Check all that caregiver endorses, and select the score for the child's usual behavior. Get examples if necessary.)***
Notes: If the child's usual behavior is to ignore, avoid, or move away from other children, score as ignoring the child (1), even if he will infrequently engage in a more typical behavior.

20. When another child approaches your child to play, how does your child <u>usually</u> respond?
Notes: If child only watches but does not respond to a child who has approached him or her to play, code this as ignoring the child (1).

21. How often does your child spontaneously imitate the actions of others without verbal or physical prompting if these are: ***(score lowest)***
Notes: If the child copies anyone, score as 0.
If a caregiver notes that the child copies a single non-communicative, somewhat atypical action (like tapping his head), then query for additional copied actions. If none are found, score as rarely/never (1).

Useful examples:
"Does your child ever copy what you're doing? For example, has he ever copied you when you're sweeping, or brushing your hair, or washing your hands with soap?"
"Is there anything that you see your child do, when you think 'he learned that from watching me'?"

22. How often does your child engage in pretend play (e.g., pretending to feed a doll, pretending to drink out of a cup, pretending to fly a toy airplane)?
Notes: Ask about pretend play that is relevant for the child's developmental level/age – pretending to eat non-food items, pretending to pet a toy animal, pretending to fly a toy plane. Asking about more advanced pretend play, like pretending to be a superhero, is less appropriate for this age range.

If pretend play would not be expected due to the child's developmental or cognitive level, score as Pretend play just beginning, and/or consistent with developmental level (0).

23. If your child does make-believe play, does he/she do this with other children, with adults, or only with him/herself?
Notes: If the child does not engage in pretend play, but has a developmental or cognitive level that suggests that pretend play would be expected, then score as Does not yet play pretend (1).

If the child does not yet demonstrate pretend play but this is consistent with developmental level, score as N/A; no pretend play, but consistent with developmental level (0).

24. How often does your child play with his/her toys in a specific, inflexible or repetitive way (e.g., lining up toys or objects in the same way each time, putting Legos together only in one specific pattern)?
Notes: This question may require that the clinician to make a judgment as to the child's behaviors. For example, if a caregiver states "child really enjoys cleaning up – he puts things away in a cabinet and then stands and opens and closes the door," the clinician may query further to determine whether the child's behaviors are often repetitive.

25. Does your child flap his/her arms and/or hands?
Notes: If flapping occurs because of poor motor control when trying to sign or do some action, do not include here.
Caregivers may have difficulty determining if the child is flapping his/her arms out of excitement (either happy or sad). Differentiating between a 0 and 1 requires that the examiner assess whether the child flaps his/her arms in response to a range of stimuli or if he/she flaps only with the most highly preferred activities. It is also useful to determine if the child uses flapping as a communicative gesture – if the child flaps when alone, this should be scored as sometimes/often (1).

Useful examples:
"It sounds like CHILD flaps his hands/arms when watching TV. Does he do this only when a really exciting scene is playing, or does he flap more often – every time the TV turns on, for example?"

26. How often does your child make unusual or repetitive movements with his/her hands or fingers? (e.g., splaying out or stiffening fingers or twisting fingers in unusual ways, splaying out arms/hands, tensing) ***(Demonstrate if respondent is uncertain what you are referencing.)***
Notes: This is a behavior very rarely seen in typically developing children.

27. How often does your child rock back and forth?
Notes: Rocking forward and backwards or side to side (as well as when sitting or when standing) are all scored here. It can be helpful for the interviewer to demonstrate this for the caregiver. Do not include appropriate rocking, such as rocking on a rocking horse or rocking chair, here. Many typical toddlers rock while sitting and sucking thumb or pacifier, when tired, or in an attempt to calm themselves, or when watching an interesting program. If the child is rocking and taking glances at a caregiver because he knows that the caregiver does not want him to rock, this is communicative and typical. More unusual rocking appears more excited, is often accompanied by hand flapping or other unusual hand movements, may look enjoyable, and may occur when the child is alone.
Some clinical judgment may be required to decide if this is within the realm of typical toddler behavior (0) or is unusual and occurs more than once per day (1).

28. How often does your child engage in unusual movements with his/her body (e.g., walking on his/her toes, jumping repeatedly, spinning, pacing, bouncing from foot to foot, tensing whole body, etc.)?
Notes: Some caregivers will have difficulty determining if their child's behavior is unusual or not – in these cases the clinician should make the judgment. The clinician is encouraged to ask the caregiver to describe or act out the behavior in question.
It can be helpful to query more about what the child is experiencing – for example, "when he spins and falls down, does he look at you to share his enjoyment and laugh?" This would be a more typical interaction than a child who spins alone and does not share enjoyment.

29. How often does your child make repeated vocalizations or unusual sounds that are not real words? (e.g., screeching and repetitive sounds like ticka ticka ticka; not meaningful word approximations)
Notes: These vocalizations should appear stimulatory. Repetition of sounds or a song that is recognizable but without intelligible words may fall under items 30 or 31 but should not be coded here. If the caregiver reports that these vocalizations are sometimes in a communicative manner and other times in a self-stimulatory manner, score as sometimes/often (1).

30. How often does your child repeat what you say (immediate echolalia; e.g., saying "You want a cookie" after being asked "Do you want a cookie" and saying "truck" immediately after hearing "Daddy drives a truck")? ***(If child has no words, score 0)***
Notes: If child repeats appropriately, like saying "wow" after a caregiver has said "wow" to share enjoyment, score as rarely/never (0).

Useful examples:
"For example, does your child often repeat the very last word or phrase that you said?"

31. How often does your child repeat phrases, conversations, or lines that he/she has heard from shows, movies, songs or books, etc. (delayed echolalia)? *(If child has no words, score 0)*
Are they repeated in the exact same way (i.e., same intonation or accent) that your child heard them?
Notes: Delayed echolalia. Code here if the child is repeating phrases or songs from another source, even if not a complete phrase or if it is repeated incorrectly. The clinician is encouraged to ask the caregiver for the source of the phrase in order to differentiate delayed echolalia from repeated vocalizations (item 29).

It is very important to clarify the difference between 30 and 31 – is the repetition immediate or delayed? If delayed, in order to be atypical it must be repeated in the exact same manner.

32. Does your child become distressed if activities or conversations are not done the same way each time?
Notes: This question is directed towards determining if the child is distressed by a change in routine. For families who say that there is no daily routine, ask about if there is a usual mealtime routine where the child has a particular place to sit, or uses a particular bowl/cup/spoon.

33. Does your child become distressed or upset if there are minor changes in his/her immediate environment?
Notes: This behavior is relatively infrequent in this age range.

34. Does your child become distressed or upset if minor changes occur in his/her environment that don't directly affect him/her?
Notes: This behavior is relatively infrequent in this age range.

35. Does your child try to impose his/her routines or rituals on others?
Notes: If child dislikes change in daily routine and actively opposes changes, code in item 32.
If giving examples to a caregiver, it is important to specify this in the context of a child's routine and differentiate this from simply denying the child what she wants in the moment. For example, if the child has a routine in which when she arrives at home, she walks to the play room and touches the toy giraffe, it would be appropriate to ask if the child becomes distressed when Grandma won't follow her.

If the child has a play date and he gets upset when the visitor tries to make something different with the Legos, or plays with toys in a different order than what the child wants, he is trying to impose the 'right way' on other children.

Be sure to differentiate between the child's fixed routines and just trying to get him to transition away from a preferred activity or treat, or a one-time preference.

Useful examples:

"Are there any rituals that he does that he wants other people to do in the same way?"

36. Is there anything that your child is interested in that seems like all he/she wants to do?
Notes: If the child's primary interest is in the TV, only code as sometimes/often (1) if the child only wants to watch a certain thing.

37. Does your child enjoy carrying around or playing with items that differ from most children his/her age (e.g., toilets, hubcaps, lights, spinning objects, vacuum cleaners, string, tools such as pliers, soup cans, hairbrushes, etc.)?
Notes: This item does not consider the duration of the interest, only the atypicality of the focus of interest. Children who are intensely interested in an item that is not clearly a toy for only a short time, after which their interest shifts to another, usually non-toy item, should be scored sometimes/often (1).

This item requires clinician judgment as to what is an atypical item of interest. Consideration of the appropriateness of the toy for the child's age and peer group, as well as the functional interest that a child may have in it should be considered. The child's environment should be considered here – a child who often carries around the water bottle that caregivers prompt him to carry into daycare each morning should not be considered atypical for this.

Many children have stuffed animals that they sleep with or carry around – do not include this here.

Sensory table:
Notes: It is appropriate for clinicians to query all sensory differences; proceeding by row or by column, based on the child's reported sensory symptoms can be helpful. It is also appropriate to integrate what you have learned about the child and ask child-specific questions. Any behaviors that are clearly sensory seeking, hypo-, or hyper-sensitivity should be written in, and should be added into the sums for boxes 17-19.

